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MISSOURI BOTANICAL GARDEN BULLETIN

VOLUME XXXIII

1945

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MISSOURI BOTANICAL GARDEN BULLETIN

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Cover: Henry Shaw's Old Residence, "Tower Grove," in winter.

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

Chrysanthemum Show, 1944

Missouri Botanical Garden Bulletin

Vol. XXXIII JANUARY, 1945 No. 1

FIFTY-SIXTH ANNUAL REPORT OF THE DIRECTOR

To the Board of Trustees:

The Director of the Garden has the honor to submit his report for the year ending December 31, 1944.

For a period of 60 years the Missouri Botanical Garden has cooperated with Washington University in the education of both undergraduate and graduate students in various fields of botanical science. Very few universities in this country, or the entire world, have enjoyed the association of facilities such as the Garden offers, and as striking evidence of the productivity of this alliance we may point with considerable pride to large numbers of prominent American botanists whose graduate work was carried on under the auspices of these two institutions. The nature of the interrelationship of the University and the Garden seems, however, to be very vaguely understood. A brief outline of the origin of this educational program would seem to be in order, although more detailed accounts will be found in the annual reports of the Missouri Botanical Garden for the past half century.

The foresight with which Henry Shaw laid out his Garden and formulated plans for its future development and care can be fully appreciated only by those who have served as staff members or students. An occasional visit to the floral display houses is not enough to give an idea of this. It became evident to Mr. Shaw in the later years of his life that if the Garden was to serve, to the fullest degree of its capacity, both botanical science and horticulture, a sound educational program must be formulated. The greenhouses and grounds were already admirably developed, and what was more, the library and herbarium were increasing with notable rapidity. The last two represent facilities which constitute the foundation of any great botanical institution. They are facilities upon which all of the scientific progress is based and in turn must be cared for by a trained technical staff who may at the same time instruct elementary and advanced students.

Thus, in 1885, about 25 years after the Garden was opened to the public, Mr. Shaw conceived a plan whereby a School of Botany might be created in conjunction with Washington University. Henry Shaw was not a technically trained man himself, and in the founding of this supplementary venture he was guided to a considerable extent by Dr. George Engelmann of St. Louis, and Dr. Asa Gray of Harvard University, two leading American botanists of that period.

In order to maintain this newly established Henry Shaw School of Botany, Mr. Shaw deeded to Washington University a piece of property in block 27 on Second Street, with the stipulation that if the income from said property should drop below a certain annual minimum the balance should be made up by the Trustees of the Garden. It may be pertinent to note at this point that the Missouri Botanical Garden and Washington University have always operated under distinct administrations. Each is controlled by its own Board of Trustees and supported by its own endowments, there being no legal obligations between the two other than the above-mentioned instance.

This annual endowment bequeathed to the University was to be used to maintain a teaching staff and provide for at least a part of the expenses incident to its work. A Chair of Botany was created at the same time under the title of the Engelmann Professorship, the first recipient being Dr. William Trelease, a botanist of note who had been a student of Asa Gray and later associated with the University of Wisconsin.

After Mr. Shaw's death in 1889 Professor Trelease became Director of the Garden, as well as Engelmann Professor, and as the School's enrollment increased assistants were added to the staff. In 1893 an instructorship was created at the University, followed a year or two later, by a second.

By 1895 a respectable list of undergraduate courses was offered, including elementary morphology, anatomy, microscopy of timbers, economic botany, applied mycology, and physiology. The graduate division was not neglected and in this same year the first degree of Doctor of Philosophy was awarded, and by 1909 the number had increased to nine. The School of Botany continued to grow in variety of courses offered, students enrolled, and size of the staff. In 1909 Dr. George T. Moore was appointed Professor of Plant Physiology and Applied Botany and three years later, upon the resignation of Professor Trelease, he assumed the Directorship.

In 1927, when Rebstock Hall was constructed on the present University grounds, the School of Botany occupied somewhat less than one half of the new building. At the present time many courses are given there, others at the Garden. The staff has been greatly increased during the present administration, consisting at present of seven full-time members of whom four

are Professors, one Associate Professor, one Assistant Professor, and one an Instructor. At least two half-time assistants, usually graduate students, as well as a varying number of part-time assistants, round out the teaching personnel.

It is evident that the School has long since expanded beyond the income from the original piece of property that Henry Shaw bequeathed to the University in 1885. Since the full-time faculty members are also attached to the staff of the Garden their salaries are carried very largely by this institution. The University, on the other hand, is responsible for the maintenance of Rebstock Hall and contributes to some extent to the professional salaries. Laboratory facilities for both teaching and research are already taxed to the limit, and it is hoped that the future may bring about the expansion in the form of a new building or an addition to the present one. Tentative plans are also being formulated for the organization of a distinct curriculum in some phase of horticulture leading to the Bachelor's degree.

A few pertinent statistics may serve to outline the achievements and scope of the school to date. From the time of its inception in 1885 over 200 graduate students have been enrolled who have remained in residence for at least one year. A number of these have been visiting scholars and not candidates for degrees. A total of 69 Doctor's degrees have been awarded and 68 Master's degrees. The practical value of the Ph.D. degree in botany is often a vexatious question in the mind of the laity. It may, therefore, be of interest to note briefly what has happened to these students after they have left the Garden and University.

Of some 94 students who have received advanced degrees since 1912, 51 are now located in teaching, administrative or research positions (or in combinations of these) in connection with colleges and universities, 21 are engaged in private industry or are with private foundations including museums and hospitals, 13 are associated with various branches of the United States Department of Agriculture, 2 are teaching in secondary schools, and 7 are in miscellaneous non-botanical occupations. We have drawn students from at least 28 states and 4 foreign countries, and they have been distributed to more than 26 states. At present 8 past students are engaged in botanical work that is directly integrated with the war program, chiefly quinine and rubber exploration in South America. At least 12 are in the armed service, including two lieutenants in the WAVES, engaged in strictly military work.

Enrollment in the graduate division is at present relatively low, as is, of course, the case with all similar institutions. There is every reason to believe, however, that it will be larger than ever following the close of the war. The staff, as well as the curriculum offered to both undergraduate and

graduate students, is larger than at any time in the history of the school and plans are under way for even greater expansion. A detailed list of courses is not given here since they may be found in the annual catalogues issued by the University.

It should be especially noted that this account does not include the many students who have received horticultural training at the Garden. Since its earliest days a varying number of students have been enrolled as apprentice gardeners, having been given some formal class work as well as an abundance of practical training in many phases of horticulture. Such work is administered entirely by the Garden, does not lead to an academic degree, and therefore does not fall within the realm of the School of Botany.

ARBORETUM

The operation of an arboretum in war-time is subject to all the restrictions which are encountered everywhere. The allotted truck mileage must not be exceeded; gasoline usage must comply with the allowance; hand tools are difficult to find; and all repair parts for tractors and heavy machinery are obtainable only after considerable waiting. The equipment must therefore be kept in operation if the development is to continue and breakdowns must be eliminated if possible. Of course, it is impossible to anticipate the breaking of a tractor drive shaft, but it is possible, by careful maintenance, to hold the gasoline consumption to a minimum and keep the machine in the field without serious loss of time. Such maintenance required 798 hours of labor during the year.

The past year not being notably dry, most plantations grew well without irrigation. The long very pleasant fall brought about an unusual display of autumnal coloration which persisted much longer than usual. About 10,000 gallons of water were hauled for use while transplanting, and 290,000 gallons were pumped to a reservoir for greenhouse and nursery use. Some groups of conifers and other evergreens were fertilized with sludge, about 15,000 gallons having been used for this purpose. The Holly *(Ilex opaca)* has shown the greatest response to this fertilizer, with the Canadian Hemlock *(Tsuga canadensis)* a close second.

For years the 374-acre farm, on the south bank of the Meramec River, has been operated as a farm on a share-crop basis. A change was made in March so that this area might be developed along with the Arboretum. Approximately 108 acres were planted to corn; some of this—two lines of white corn raised for the University of Missouri, Papago, and other sweet corns—were wholly experimental. While the entire crop has not been harvested, it appears that production will reach 4,000 bushels. In addition, 684 bushels of soybeans and 1,167 bales of clover and alfalfa hay were

Part of herd useful in establishing blue-grass areas by mowing, hoof action and manure

Ferry across the Meramec connecting the Farm with the Arboretum

harvested. It is well known that good crops cannot be raised on the same field year after year simply by planting seed each spring. Both the bushels per acre of corn and the ultimate size of a Pine tree depend, most of all, on soil fertility. There are other factors involved, but only starving trees and stunted crops can be grown on a starved soil. The extraordinary growth of Boxwood at the Main Gate, the Taxads at the Trail House, and the establishment of 1,500 Short-leaf Pines, are all largely due to the generous use of cattle manure. When enough is applied to a nursery soil, it has been found that the plant mortality rate drops, and the plants "catch" and grow from the start. The need for manure increases annually, aside from that required with each new group of plants, but only a limited amount can be purchased. To help supply some of the needs a herd of Aberdeen-Angus cattle was placed on the Farm (pl. 2) with the thought that some manure from the feed barn will be available.

One of the obstacles to efficient operation of the Farm has been the very long, rough drive from the Arboretum—a matter of 12½ miles. With mileage and gas restrictions and the time lost in driving, only occasional inspection trips could be made. This problem has now been solved by the building and operation of a ferry on the Meramec River (pl. 3), which brings the Farm within ten minutes of the Arboretum and saves twenty miles each round trip. The barge is of all-steel construction, the skeleton being made of used boiler tubes covered with steel sheets. It was assembled in units hauled by our truck to the river bank, where it was welded into one piece and launched. It is 14 feet wide and 30 feet long, and displaces 63,000 pounds gross weight.

Much clearing has been done east of the Pinetum and north of the East Bridge, and about one mile of roadway has been rough-graded. It is planned to open this area when it becomes possible to haul gravel for road surfacing. Four culverts are in place and Brush Creek is to be crossed with a concrete slab laid on the creek bed. The opening-up of this region will permit the extension of evergreen plantings, and since it is a south slope with many sheltered locations more exacting plants might be expected to be grown here. For instance, it would allow the development of the Boxwood Garden on a scale made necessary by the many thousands of these plants now in our nurseries.

Nursery work has been restricted to plants which were needed or which would be used in a specific manner or place. This means that fewer species are being grown and more attention is being paid to special kinds. Actually it would be quite impossible to obtain foreign seeds and plants. These conditions should result in reducing the nursery work, but the nurseries and seed-frames are full, an inventory showing 18,737 plants. Many

thousands of cuttings of Boxwood, Taxads, Junipers, etc., have been made. During the fall two large groups of White and Colorado Blue Spruces were moved to avoid crowding, and many smaller trees were planted.

A small lake near the Crabapple collection was enlarged and deepened. It is expected that it will reflect the great masses of Crabapples which flower here each spring, and it is being tentatively called "Mirror Lake." The Missouri Conservation Commission, through Mr. Aden C. Bauman, Aquatic Biologist, plans to use this lake for experimental fish rearing.

The threat of a woods or a grass fire at the Arboretum has always been serious, and during the past five years much preventive work has been done. Fire trails have been opened, reservoirs and fire hydrants installed, a telephone alarm system worked out, and mowing and clearing has reduced or eliminated fuel from the soil surface. In spite of such precautions, the possibility of a big fire remains a worry and in dry seasons a nightmare. A fire sweeping through the Pinetum might destroy the work of twenty years in twenty minutes, and no sum of money would replace the dead and damaged trees. Much can be done in the way of preventive work, but eventually it becomes necessary to think in terms of fire control—how to put out a fire which has started. Last spring the Arboretum was presented with a high-pressure pump, hose and guns, all of which have been installed on the tank truck. This equipment is now almost the only "fog" fire-fighting unit in civilian hands. It is patterned after the latest "crash" truck in military use, and should prove of great value if a fire should occur. Fire control has gone one step farther by the organization of the Gray Summit Volunteer Fire Department—a group of men who have contributed both time and funds to purchasing ladders, lights and other equipment needed in protecting community property. The Arboretum has agreed to dispatch our truck to any fire within the community and the Volunteer Department has agreed to answer any call for help which might arise in this vicinity. This long-anticipated organization of trained fire-fighters should go far toward removing the ever-present threat that a careless smoker might destroy the Pinetum.

"*Friends of the Garden*" *Fund*.—As was reported last year, this fund is being allowed to accumulate until labor and material can be obtained to complete several important improvements. It is a satisfaction to know that because of the sustained interest of Garden Clubs and individuals the money necessary for this work will be available as soon as conditions permit its economical use. During the year 1944, $5,216.24 has been added to this fund.

Orchids.—In addition to the annual orchid exhibitions staged in the Floral Display House during February, the alcoves in the Aroid House have presented a continuous display throughout the year, plants being brought in weekly from the Arboretum. In addition to the better-known Cattleya group, many other genera were included, such as Aerides, Vanda, and the white form of *Laelia anceps*, presented to the Garden in 1918 by the late D. S. Brown. Filling the alcoves were the yellow sprays of "Dancing Girls" *(Oncidium ampliatum)* in May, with *Oncidium varicosum Rogersii* during September and October. The rare *Oncidium Powellii* is now represented by twelve plants propagated from the original specimen sent from the Canal Zone. This and the showy Tiger Orchid *(Oncidium tigrinum)* from Guatemala were on display during February.

Of the so-called "botanical orchids" a special feature was twelve plants of *Bulbophyllum Medusae*, each carrying six to eight flowering spikes. Other genera included Brassia, Cirrhopetalum, Epidendrum, Eria, Brassavola, Lockhartia, Catasetum, Stanhopea, Zygopetalum, Megaclinium, and *Coelogyne Dayana* (the Chain Orchid which produced flowering spikes five feet long).

Special attention has been given to the propagation of the more showy hybrids of Cattleya of which we now have thousands of promising seedlings. The slipper orchids convoyed from England, as well as the Brownhurst *Cypripedium insigne Sanderae* and *C. Maudae*, have been propagated by division to increase the stock of these beautiful flowers. The Sherman Adams Cypripedium seedlings, purchased in June, 1943, have now reached the flowering stage. These hybrids were bred from the finest English stock and will greatly enhance the Garden collection. The number of plants transplanted and repotted during the year was 18,739.

While the orchid collection is under the general charge of Mr. George H. Pring, Superintendent to the Garden, Miss Rosemary Heinz and Mrs. Elsie George, with the assistance of four other women, are responsible for the care and growing of some 20,000 plants housed at the Arboretum.

Sunshine Record.—

COMPARATIVE HOURS OF CITY AND COUNTRY SUNSHINE

Month	*City Garden* *Hours*	*Arboretum* *Hours*
January	147.45	154.15
February	125	142.45
March	155	164
April	173.45	172
May	204.30	224.45
June	285	321

July	282.15	314.15
August	221	236
September	206.30	210
October	250.30	250
November	91	78
December	69.15	87.30
	2211.30	2354.30
		2211.30
Excess of sunshine hours at Arboretum		143.00

CITY GARDEN MAINTENANCE

Some idea of the work necessary to maintain the heating and water systems in a plant now over thirty years old may be obtained from the following list of repairs and replacements during 1944:

Repaired reducing valves in upper valve chamber at experimental valve chamber.

Repaired all traps in three manholes.

Installed new diaphragms in all reducing valves.

Renewed all packing on boiler and vacuum pumps.

Renewed packing on three manhole expansion joints.

Installed 2″ city water line for No. 1-2-3 boilers.

Installed new brick arch under No. 2 boiler.

Repaired electric sump pump.

Repaired boiler feed pump.

Cleaned 368 motor valves on end of heating coils, and where necessary installed new valves.

Installed ¾″ hot-water pipe for washing pots in Head House.

Repaired 3 traps in upper valve chamber at the Experimental Greenhouse.

Cleaned shell and all tubes in No. 1-2-3 boilers.

Renewed 6 stand pipes for sprinkler heads in Rose and Linnean Gardens.

No extraordinary repairs or improvements were attempted. The necessary replacements were made, and more than the usual amount of painting was completed, including the iron and wire fence on Alfred and Magnolia Avenues, and the ornamental iron fence surrounding the Mausoleum.

GARDENS

During February and March some of the shrubs in the vicinity of the Floral Display House were pruned or transplanted. Many of the hawthorns which surround the rose garden were pruned to permit more light to reach the plants underneath these trees. Narcissi and scillas from other parts of the garden were planted in these beds in the fall, and several thousand ivies and *Vinca minor* were added to the area of ground-cover plants. None of these plants were purchased but were propagated by cuttings last winter whenever weather conditions permitted.

All of the major gardens were manured in the spring before the beds were spaded. The fine display of roses, particularly in the autumn, might be attributed to the manure mulch.

Several new varieties of perennials were added to the Linnean Garden, the most noteworthy of which were six varieties of tree peonies.

In the two previous years ornamental vegetables were combined with the bedding plants in the Main Garden but during the past summer only flowering plants were used. The sample Victory Garden, however, was maintained for the third consecutive year.

A collection of farm crops and fiber plants was again grown in the Economic Garden where, for the last two years, the beds had been planted with a large variety of vegetables.

Forty new varieties of iris were purchased. The Iris Garden is gradually being improved through the gift and purchase of many of the current popular varieties.

A new nursery was established in the spring for the purpose of growing a supply of evergreens for garden and floral display use. Five-hundred plants, representing seventeen varieties of evergreens, were lined out in this nursery in April.

FLORAL DISPLAYS

The orchid show was held in the Floral Display House from January 23 to February 20. There then followed a succession of displays of primroses, cyclamens, nasturtiums, cinerarias, marguerites, stocks and calendulas. An Easter show, with azaleas and regal lilies predominating, opened on April 2. From April 16 to May 14 schizanthus, annual chrysanthemums, foxgloves, canterbury bells and Martha Washington geraniums were displayed. More than 200 plants were sent to the Christ Church Cathedral for the annual flower sermon preached there on April 16. The St. Louis Horticultural Society held its spring flower show in the Floral Display House on May 20 and 21, and a week later the hydrangea show opened. Fancy-leaved caladiums occupied the House during the summer months. The Greater St. Louis Victory Garden Harvest Show was held September 9 and 10. The St. Louis Horticultural Society held its annual dahlia show on September 30 and October 1. The annual chrysanthemum show opened on November 5 and continued until December 3. The Christmas display of poinsettias and chrysanthemums opened on December 10, and will continue into early January.

As in the past, the growing of the plants, as well as the arrangement of the floral displays, has been the special charge of Mr. Paul A. Kohl, Floriculturist to the Garden. He also has the responsibility of many of the outdoor gardens.

MAIN CONSERVATORIES AND EXOTIC RANGES

The flowering of outstanding exotics and the acquisition of new plant and seed material appear to be the features most worthy of recording for 1944. During the year several good contacts with various botanists and plant-lovers were made, through which plants, cuttings and seeds were secured. Included in the group of prominent donors were: Drs. Robert W. Schery, Robert E. Woodson, Jr., and Leon Croizat; Messrs. Mulford B. Foster, Dave Barry, Jr., Frank J. McCoy, E. O. Orpet, Frank D. Venning, Alex D. Hawkes, Horace W. Smith, E. J. Alexander, Thomas MacDougall, and Joseph Holmes; Miss Lester Rowntree; Mrs. Mary Diddell; Capt. A. A. Bernhardt; and the Plant Introduction Garden of Coconut Grove, Florida.

As regards seeds, often the amount received was just sufficient for one sowing, but where a larger quantity was to be had several sowings were made at intervals to insure germination. In some cases germination was poor, but in others quite satisfactory. Some seedlings attained sufficient size to be transplanted into permanent beds of the conservatories. Most of Schery's seeds were collected in northeastern Brazil and consisted of cacti, bromels and miscellaneous woody material; Hawkes and Venning were instrumental in procuring seeds of native and introduced plants in Florida gardens; McCoy, Orpet, and Rowntree shipped seeds of native California plants; and Capt. Bernhardt sent material from various locations where he was stationed in the United States and overseas.

Much worth-while living material, including the valuable Cinchonas, *Cycas Wadei*, and a number of new cacti and succulents came into our possession. *Cycas Wadei*, a recent discovery, grows in a very small area on the Island of Palawan in the Philippines. Anticipating the war with Japan, David Barry of California sent a request to Dr. Wade, head of the leper colony on Palawan, to collect all the seed of this rare cycad that could be gathered and air-mail it to California for propagation. Mr. Barry also delivered to us other seedling cycads, including *Encephalartos Hildebrandtii*, *E. gratus* and *Macrozamia Fraseri*, also a number of rare bromels, among them plants of three odd and rare genera—Catopsis, Fascicularia and Gravisia —which previously were not in our collection. This addition raises our number of genera in the Bromeliaceae to 31, or about three-fifths complete.

In February, Ladislaus Cutak was sent to Florida to study the very extensive collection of bromels in Foster's establishment in Orlando and to negotiate a mutual exchange of plants. The Garden now possesses a very commendable representation of the Bromeliaceae—probably the best of American gardens in the number of species. Both epiphytic and xerophytic types have received attention, and many of them are attached to the trunks

of palms in the Palm House or growing in the beds of the Cactus House where they are beginning to make splendid growth. Besides the bromels, many other exotics were obtained, including several miscellanea which Foster had collected on trips to tropical regions. While in Florida, Cutak made other contacts, particularly with Mrs. Mary Diddell of Jacksonville, an amateur botanist, who supplied plants of araceous, liliaceous and cactaceous character.

The collection of palms was augmented by a shipment of specimens from the U. S. Plant Introduction Garden of Coconut Grove, Florida, which were large enough to be set out in permanent locations in the Palm House. Several of these palms come from regions in the Philippines still occupied by the enemy.

In the latter part of November Mr. E. J. Alexander, of the New York Botanical Garden, and Mr. Thomas MacDougall, a landscape designer from New York, brought a nice lot of crassulaceous and cactaceous plants for deposit at the Garden. These gentlemen were on their way to the unexplored regions of Mexico, where they will conduct a six-months collecting trip for botanical and horticultural material. Mr. MacDougall has collected in Mexico for the past fifteen years, and has discovered a number of new cacti, echeverias, graptopetalums and sedums, all described by Mr. Alexander in the *Cactus Journal*. Of particular interest were *Sedum platyphyllum* (which resembles an African Cotyledon), *Lobeira MacDougallii* (a new monotypic cactus), *Pseudorhipsalis macrantha*, *Echeveria alata*, *E. bella*, *E. spectabilis*, and several new crassulaceous plants which have not yet been described.

Of general interest were plants flowering for the first time with us. In this category the cacti were dominant, particularly the nocturnal kind belonging to the genera Acanthocereus, Hylocereus, Mediocactus and Selenicereus. These genera are characterized by being elongated and vine-like, possessing the largest flowers in the Cactaceae. The Mexican *Acanthocereus occidentalis* bloomed for the first time on the night of June 15 and produced flowers up to nine inches long throughout the summer. Exceeding them by three inches, however, were those of *A. colombianus*, which opened on July 10. *Hylocereus Lemairei,* another first-nighter and one of the most beautiful of all nocturnal bloomers, appeared on June 22; *Eriocereus tortuosus* made its bow on August 21; *Selenicereus hondurensis* displayed its floral charm on June 25; and *Mediocactus coccineus* on June 6. The last possesses Hylocereus-like stems, but its flowers are more like those of a Selenicereus without the hairs of that genus.

In the South African House the flowering succulents held sway during the winter season. Of especial note were a number of Aloes, several bloom-

ing for the first time. Among these *Aloe africana*, *A. arborescens* var. *pachythyrsa* and *A. rubrolutea* were outstanding. *Aloe Johnstonii* continued to be most profuse of the flowering aloes, sending up stalks of orangish flowers from nearly every rosette. As in past years, leaves of the medicinal *Aloe vera* were supplied to doctors and hospitals when urgently needed. A small bed of these plants is kept for this purpose.

In the Economic House the bright green, fern-like *Jacaranda mimosaefolia* sent forth pyramidal panicles of deep lavender blossoms for the first time in March. So also did *Plumieria acutifolia*, whose flowers are of a delectable gardenia-white with a golden throat and used in the South Seas in making leis. An interesting Sansevieria, with very broad, coriaceous leaves, orange-cinnamon creeping rootstalks, and a dense head of whitish-green flowers, also condescended to bloom for the first time and proved to be S. *longiflora*, a native of the Belgian Congo. This species is still rare in collections but is bound to increase in popularity when it is available for distribution. We have been making special effort to secure as many of the true species of Sansevieria as possible, and already have a rather worth-while start with 11 species of the known total of fifty-four.

Squirrels, which inhabited the Main Conservatory for the past few years, became a great nuisance and had to be reduced in number. On April 22, when five inches of rain fell in eighteen hours of intermittent downpour, the tunnel under the Main Conservatory was flooded seven inches deep—the first such occurrence since the greenhouses were erected in 1913. The sewers would not take the water, and the long chamber in the tunnel was transformed into a canal which rolled on toward the boiler room, causing the heating units to be abandoned for the day.

The regular routine work, such as watering, spraying, cultivating, fertilizing, planting and pruning was carried on faithfully as usual, all under the management of Mr. Ladislaus Cutak, in charge of the Main Conservatory, including cacti and other succulents.

EXPERIMENTAL GREENHOUSES

Research work on the growth of orchid plants, under the direction of Dr. D. C. Fairburn, Horticulturist to the Garden, continues to be the major field of activity. Many thousands of hybrid seedlings, raised by various methods, are under observation in an effort to determine what combination of cultural factors is required to obtain maximum growth and flowering. Investigations now in progress are:

Growing orchid plants by gravel culture methods or "Hydroponics."—Results of these experiments have been so favorable from several angles that new and more extensive studies are under way to learn what the ultimate possibilities are of raising orchids in gravel flooded periodically with nutrient

solution. A large concrete bench, especially designed for this type of work, has been constructed at the Arboretum greenhouses and over 5500 hybrid seedlings planted in it to demonstrate the value of hydroponics on a comprehensive scale.

A summary of the results obtained to date on these experiments, published in the October 1944 issue of the Garden BULLETIN, has aroused considerable interest among orchid growers, professional and amateur, throughout the country.

Supplementary feeding with nutrient solutions.—It has been demonstrated beyond question that orchid plants potted in osmunda fibre respond favorably to the application of certain nutrient solutions. Evidence to this effect is apparent sooner with young seedlings than with mature plants. Data regarding the frequency of application are being compiled.

Transplanting seedlings from culture flasks directly into community pots of gravel.—This method has definitely eliminated a lot of slow, tedious work formerly involved in the use of orchid peat in the community pots. Details of this new technique were published in the October 1944 issue of the Garden BULLETIN.

Potting orchid plants in gravel instead of osmunda fibre. — Several thousand plants potted in granite gravel and fertilized at regular intervals with nutrient solutions are under observation to see if they grow as well or better than plants potted in osmunda fibre and handled in the usual manner. Similar tests are also being made on Sani-Fibre or shredded bark from the Redwood trees of California.

Correlation studies.—Data are being recorded to see if the size and vigor of orchid seedlings are definitely correlated with the quality, quantity and earliness of bloom.

Use of electric light at night to stimulate rapid growth of seedlings.—Experiments thus far indicate that artificial light may be of some advantage under certain conditions. Further tests are needed.

Effect of sunlight.—Detailed studies on the optimum amount of sunlight required for the growth of orchids in Missouri have been concluded. A complete report of this investigation will soon appear in the Garden BULLETIN.

Comparative growth responses of seedlings on various nutrient media in the culture flasks.—Germination of orchid seed and growth of seedlings in the flasks depend to a large extent on the composition and concentration of the nutrient elements in the culture media. Considerable progress has been made toward developing improved formulas for this type of work. Symbiotic cultures, using selected strains of endemic fungi, have in all cases given results far superior to anything produced by sterile culture methods.

Effects of increased humidity on orchid plants.—The installation of a DeVilbiss spray gun, operated at 90 pounds air pressure, has made it possible to reproduce artificial fog in the greenhouse comparable to the early morning mists found in the mountainous regions where many orchids grow wild. Indications are that this fog will stimulate growth considerably.

A Bahnson Humidifier, with a fan and rotating disk to create mist, has also been tried, but the results were not as satisfactory as with the DeVilbiss spray gun.

New "Wardian Case" enclosures, consisting of transparent Vitapane tacked to light wooden frames and having removable covers that operate on the windlass principle, have been constructed over the benches containing orchid seedlings in community pots. An arrangement of this type greatly assists in the maintenance of a humid atmosphere, so essential for active growth of young seedlings freshly transplanted from culture flasks.

Colchicine treatments.—To develop mutations that might not arise through hybridization, orchid seeds are being treated with various concentrations of colchicine. Some rather striking growth responses have already been noted.

AMATEUR GARDEN COURSE

Considerable time and greenhouse space have been used for the propagation of house and garden plants, most of which are used for class work. Over 5,000 cuttings and countless seedlings were raised in the Experimental Greenhouse by members of the amateur garden class for subsequent use in their own homes and gardens. Particular attention was given to the production of vegetable seedlings for planting in back-yard "Victory Gardens."

SUPERVISED INSTRUCTION FOR SCHOOL-CHILDREN

The eight years in which the school-children have had the opportunity to visit the Garden under the guidance of a special nature-study teacher have demonstrated the value of this work, not only to the pupil, but to the school-teacher and parent as well. Miss Clara M. Heising, who since 1936 has been delegated by the Board of Education for this special instruction, conducted more than 9000 students through the Garden in 1944, in spite of the present limited means of transportation. As has been pointed out before, this is not a mere sightseeing trip, but is a serious effort to open the eyes of boys and girls to the beauty and wonder of nature. As they become "tree-conscious," "plant-conscious," "insect-conscious" or "bird-conscious" the pupil develops hobbies and habits for leisure hours that are of inestimable value.

The Missouri Nature Knight program was presented to three schools adjacent to the Garden, resulting in groups of children meeting two after-

noons a week for special nature-study. Classes and clubs from the schools are taking advantage of the material available here for stimulating interest in some particular subject. Recently classes are making their visit to the Garden the basis of their graduation programs, and more and more individual pupils and teachers, as well as classes, write letters telling how much their visit to the Garden was appreciated.

RESEARCH AND INSTRUCTION

Dr. J. M. Greenman, Curator of the Herbarium and Professor in the Henry Shaw School of Botany of Washington University, has continued to devote most of his time to exacting duties in the herbarium. He has also supervised the work of graduate students majoring in taxonomy of the higher plants. Furthermore, Dr. Greenman has continued to pursue research on various groups of flowering plants and to further monographic and floristic studies long under way.

Dr. C. W. Dodge, Mycologist to the Garden and Professor in the Henry Shaw School of Botany of Washington University, has spent most of the time available for research in completing the study of lichens from the Australian quadrant of Antarctica and the subantarctic islands of the Indian Ocean and of Macquarie Island. The usual courses of instruction have been given. Miss Dorothy Gaebler gave the course in general bacteriology during the summer session. Routine determinations of human pathogenic fungi from the armed forces have been made as the various cultures were received. Several series of lichen specimens, especially from Texas and Cuba, have been determined for correspondents. Several antiseptic paints were tested for the St. Louis Ordnance District in the control of decay of ammunition boxes in the South Pacific.

Mr. Emanuel Grunberg, a graduate student in Yale University, spent a semester in the laboratory of mycology, studying human pathogens.

Dr. Edgar Anderson, Geneticist to the Garden and Engelmann Professor of Botany in the Henry Shaw School of Botany, returned to St. Louis in April, 1944. A fellowship from the Guggenheim Foundation and a special grant from the Rockefeller Foundation had allowed him to carry on his survey of *Zea Mays* in California and in Mexico for fourteen months. A portion of the results have already appeared in the ANNALS for November 1943 and for November 1944. Surveys of the maize of the American Southwest and of Mexico are now undergoing final revision. Since his return to this country a large part of his time has been given over to supervising the assembly of a maize herbarium in which photographs of the original ears, samples of the kernels, and herbarium specimens of the tassels are brought together with notes on the growth habit of the plant. Approxi-

mately 1500 such specimens have been prepared and mounted, and material for 500 more is at hand. It is expected that when complete the collection will be in the neighborhood of 3000 specimens and will present an effective survey of the varieties and races of the maize of the entire world, including prehistoric collections.

A number of projects connected with this general survey have had to be postponed because there were no facilities at the Garden for growing large experimental fields of pedigreed maize. An arrangement with the Pioneer Hi-Bred Corn Company, of Des Moines, Iowa, has removed this difficulty and several projects are already under way. Dr. Anderson spent a few days in April and three weeks in August and September at the company's breeding farms at Johnston, Iowa.

In addition to his regular teaching assignments in the Henry Shaw School of Botany, Dr. Anderson cooperated with the zoology department in organizing a special seminar course in a survey of biology for a selected group of students from the Medical School.

Dr. Robert E. Woodson, Jr., Assistant Curator of the Herbarium, as in former years, has divided his time between teaching duties as Associate Professor in the Henry Shaw School of Botany and various research projects conducted at the Garden. These projects include preparation of manuscript for current fascicles of the "Flora of Panama," published serially by the Garden, and various topics concerning the Asclepiadaceae and Apocynaceae.

Dr. Henry N. Andrews, recently appointed Assistant to the Director, and Assistant Professor in the Henry Shaw School of Botany of Washington University, as a result of the closing of most of the University's Army training programs, has been relieved of duties in the mathematics department and is again able to devote full time to botanical and administrative work.

In September a small but choice collection of coal balls (containing fossil plants from the Coal Measures of Iowa) was obtained by gift from Mr. F. O. Thompson of Des Moines. Dr. Andrews' research activities at present are being devoted entirely to this collection. Perhaps the most important plants found to date are stem remains of the seed-ferns. A distinctly new and beautifully preserved specimen of Medullosa (a polystelic group) is being studied, as well as a stem apparently related to the Lower Carboniferous seed-fern Rhetinangium, from Scotland. The latter, however, presents characters that will probably render necessary its description as a new genus. It is expected that this material will be ready for publication in an early issue of the ANNALS.

Fern fructifications and seeds are also well represented in this collection. Serial peel preparations, as well as ground thin sections, are being prepared,

and a study of this material will immediately follow when the seed-fern stems have been described.

Dr. Carl C. Lindegren, Research Professor, Gertrude Lindegren, Research Fellow, and Mrs. Amy Pabor Bates, Research Assistant, in the Henry Shaw School of Botany of Washington University, have carried on a program of penicillin research in addition to their studies on the genetics of yeast. The yeast work has concentrated on the development of new hybrids which have proved to be of interest both industrially and scientifically. An analysis of the progeny of some hybrids proved that adaptive enzymes are transmitted in the Mendelian manner. The culture collection of yeasts and hybrids now consists of about 1,000 strains. This work has been generously supported by Anheuser-Busch, Inc., St. Louis, and a grant was also received from the American Philosophical Society.

Degrees.—At the May 1944 Commencement the degree of Doctor of Philosophy was conferred upon Ralph O. Erickson, B.A., Gustavus Adolphus College, St. Peter, Minn., M.S., Washington University (Taxonomy and Cytology). The degree of Master of Science was conferred upon Charles B. Heiser, A.B., Washington University (Taxonomy), and Dorothy Gaebler Heiser, A.B., Washington University (Mycology).

Instructor.—Charles B. Heiser was appointed Instructor for the year 1944-45, at the same time continuing his research work in taxonomy.

Graduates and Fellows: The following appointments were made in the Henry Shaw School of Botany for the year 1944-45:

Graduate Assistants: Dorothy G. Heiser (half time); Ellen M. Kern and Julia Guzmán-Naranjo (quarter time).

University Fellow: Lillian Nagel, B.S., University of Illinois; M.S., University of Colorado (Cyto-genetics).

Institute of International Education Fellow and University Scholar: Julia Guzmán-Naranjo, A.B., Universidad Nacional de Bogotá, Colombia, S. A.

Henrietta Heerman Scholar: Ellen M. Kern, A.B., Washington University (Morphology).

University Scholar: Mattie L. Smith, B.S., M.S., Emory University, Atlanta, Ga.

Published Articles.—

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Anderson, Edgar: Cytological Observations on *Tripsacum dactyloides*. Ann. Mo. Bot. Gard. 31:317-323; Homologies of the Ear and Tassel in *Zea Mays*. Ann. Mo. Bot. Gard. 31:325-342; "Maiz del Pais" in California.

Jour. Calif. Hort. Soc. 5^{2}:1-6; Maíz reventador. Ann. Mo. Bot. Gard. 31:301-314; Mass Collections. Chron. Bot. 7:378-380; Notes on Variation in *Tithonia tubaeformis*. Ann. Mo. Bot. Gard. 31:239-240; The Sources of Effective Germ-plasm in Hybrid Maize. Ann. Mo. Bot. Gard. 31:355-361; Two Collections of Prehistoric Corn Tassels from Southern Utah. Ann. Mo. Bot. Gard. 31:345-352; with Hugh C. Cutler: Una nueva especie de Maidea sudamericana del genero Tripsacum. Rev. Argentina de Agron. 9:249 (translated from Ann. Mo. Bot. Gard. 28:259-260); with Dorothy Schregardus: A Method for Recording and Analyzing Variations of Internode Pattern. Ann. Mo. Bot. Gard. 31:241-247.

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Heiser, Charles B.: Monograph of Psilostrophe. Ann. Mo. Bot. Gard. 31:279-300; Quinine or Malaria. Mo. Bot. Gard. Bull. 32:33-40 (reprinted in Chemurgic Digest 3:74-78).

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Schery, Robert W.: Some Secondary Rubbers in Ceará, Brazil. Mo. Bot. Gard. Bull. 32:41-50; with Robert E. Woodson, Jr.: Flora of Panama. Part II, Fasc. 3. Ann. Mo. Bot. Gard. 31:1-172.

Woodson, Robert E., Jr.: Apocynaceae and Asclepiadaceae, in Standley, P. C. and J. A. Steyermark: Studies of Central American Plants—IV. Field Museum Publ. Bot. 23:78-81; Apocynaceae, in Moldenke, H. N.: Flora of Extra-tropical America. Lilloa 10:328; Miscellaneous New Asclepiadaceae from Tropical America. Ann. Mo. Bot. Gard. 31:235-237; Notes on Some North American Asclepiads. Ann. Mo. Bot. Gard. 31:363-370; with Robert W. Schery: Flora of Panama. Part II, Fasc. 3. Ann. Mo. Bot. Gard. 31:1-172.

Scientific and Popular Lectures.—

Dr. Edgar Anderson, Geneticist to the Garden: May 5, as a garden expert in the Garden Quiz Clinic at the meeting of the St. Louis Horticultural Society; April 24, genetics and botany seminars at Iowa State College, "The Genetics of Species Crosses"; July 3, over Radio Station KFUO, "Flowers in the City Art Museum"; October 26, before the Junior Academy of Science, "Maize in Mexico."

Mr. August P. Beilmann, Manager of the Arboretum: January 19, before the Rural Fire-fighting class, at Pevely, Mo., "Reducing the Fire Hazards in Fields and Wood-lots"; September 15, before the Clayton Garden Club, "Tree Care."

Mr. Ladislaus Cutak, in charge of Succulents at the Garden: April 4, before the Grantwood Garden Club, at Affton, Mo., "Cacti and Succulents;" April 18, before the Zeta Beta Chi Sorority, and May 2, before the Business

and Professional Womens' Group of the Y.W.C.A., "Gardens of Florida"; June 8, before the Bible Class of the Y.M.C.A., and October 19, before the Webster Groves Garden Club, Group No. 2, "A Cactus Hunt in Old Mexico"; November 10, before the Founders Circle of the Rosemary Garden Club, at Pattonville, Mo., "Cacti, the Ideal House Plants."

Dr. Carroll W. Dodge, Mycologist to the Garden: February 16, before the Mothers' Club of the Alpha Xi Delta Sorority of Washington University, "Central American Culture"; February 24, before the Quota Club International, and March 10, before the St. Louis College Club, "The Working of our Good Neighbor Policy in Central America"; May 9, before the University City Kiwanis Club, and May 17, before the Northside Kiwanis Club, "Central American Problems."

Dr. David C. Fairburn, Horticulturist to the Garden: January 4, before the Ladue Garden Club, "Spring Gardening"; January 24, before the Four Seasons Garden Club of Webster Groves, "The Fragrant Garden"; February 24, before the Gardening Clinic of the East-central Region, sponsored by the Missouri Federation of Women's Clubs, "Seed Sowing and Transplanting"; March 3, before the Botany I class of Washington University, "Gardening"; March 14, before the Parent-Teachers' Association of the Meramec School, "Planning, Planting, and Maintenance of Victory Gardens"; August 15, before the Garden Club of Gerard, Pa., and August 3, before the Garden Club of Syracuse, N. Y., "Orchids from Seed to Flower"; September 15, before the Webster Groves Garden Club, "House Plants."

Mr. Paul A. Kohl, Floriculturist to the Garden: "Victory Gardens," February 21 and 28, at the East Richmond Heights School, and February 24, and March 2, at the West Richmond Heights School; May 5, as garden expert in the Garden Quiz Clinic at the meeting of the St. Louis Horticultural Society.

Dr. Carl C. Lindegren, March 3, before the Faculty Wives Club of Washington University, "Yeast and Diet"; April 4, before the Junior Academy of Science, "The Story of Yeast"; September 11, before the Mycological Society, Cleveland meetings, A.A.A.S., "Genetical Studies of *Saccharomyces cerevisiae*"; November 17, before Sigma Xi, Purdue University, "Inheritance of Adaptive Enzymes."

Mr. G. H. Pring, Superintendent of the Garden: January 27, before the Clipper Club at the Tyler Place Presbyterian Church, and February 1, before the Ladue Garden Club, "Collecting Para Rubber"; February 13, before the Alumni Chapter of Kappa Alpha Theta, "Orchids throughout the Year"; February 28, before the Little Gardens Club of University City, February 29, before the Maplewood Rotary Club, and March 1, at the noonday meeting of the West End Kiwanis Club, "Tapping the Para Rubber

Tree"; March 8, before the Rotary Club of Kirkwood, Mo., "Hunting Orchids in the Tropics"; March 15, before the Webster Groves Garden Club, "Trees"; May 26, over Radio Station WIL, "Victory Gardens"; June 15, before the Rotary Club of Clayton, and September 21, before the Rotary Club of Edwardsville, Ill., "Collecting the Para Rubber"; July 20, before the Franklin-Gasconade Firemen's Association meeting at the Garden Arboretum, "Orchids from Seed to Flower"; October 12, before the meeting of the St. Louis Chapter of the Daughters of the American Revolution, "Activities of the Missouri Botanical Garden"; November 13, before the Alpha Chi Sigma fraternity, and November 20, before a group of Business and Professional Women, "The Development of the Orchid from Seed to Flower"; November 21, before the Men's Club of Peters Memorial Presbyterian Church, "Collecting Para Rubber."

THE HERBARIUM

The usual routine work of the herbarium has continued throughout the year. However, the amount of new material acquired has been considerably less than in the same period of time for several decades. This is due wholly to conditions incident to the present war. This reduction in the amount of new material acquired has afforded an opportunity to work up, mount, and incorporate in the organized collections many specimens which had accumulated in past years.

The larger and more noteworthy collections obtained are as follows:

New Accessions.—E. Anderson, 63 plants of Mexico and of horticulture; Arnold Arboretum, Harvard University, 232 plants of Cuba; Fred Barkley, 270 plants of Texas and 85 plants of Mexico; Louis G. Brenner, Jr., 21 mosses from Oregon; Chicago Museum of Natural History, 106 plants from various countries including Hawaii; Mrs. M. S. Clemens, 53 plants from Oceania; Henry S. Conard, 35 mosses from Iowa; Mrs. Alice Cornman, 44 plants of Florida; George L. Fisher, 168 plants of Mexico; Gray Herbarium, Harvard University, 54 miscellaneous duplicates including illustrations and photographs and 12 plants of Mexico; Roland M. Harper, 74 plants of Alabama; L. C. Hinckley, 15 plants of Texas; Charles B. Heiser, Jr., 50 plants of Arizona and Indiana; James C. Hinton, 1000 plants of Mexico; Leslie Hubricht, 553 plants of Virginia; Iowa State College, 28 plants chiefly from Iowa; Ellsworth P. Killip, 17 ferns from Panama; W. A. Murrill, 143 plants of Florida; New York Botanical Garden, 378 plants from Utah, South America, and India; North Dakota Agricultural College, by O. A. Stevens, 250 plants of North Dakota; Rocky Mountain Herbarium, 250 plants of the Rocky Mountain region; Bernardo Rosengurtt, 88 plants from Uruguay; Paul Schallert, 146 plants of Arizona and California; State University of

Iowa by G. W. Martin, 62 fungi from various localities; U. S. National Museum, 342 plants from Mexico, West Indies, and South America; University of California, by T. H. Goodspeed, 388 plants of Mexico and South America; University of Illinois, 1023 plants of Illinois; University of Oklahoma, 125 plants of Oklahoma; University of Texas, 1178 plants of Texas; University of Wisconsin, 101 plants of Wisconsin; Hermann von Schrenk, 21 plants of Missouri and Idaho; Eula Whitehouse, 32 plants of Texas.

Numerous smaller collections, chiefly gifts, have been received during the year; these have been recorded in the current monthly issues of the MISSOURI BOTANICAL GARDEN BULLETIN. The above condensed record clearly indicates those parts of America from which the largest amount of material has been received. Thus, it may be seen, as in 1943, that western and southwestern United States, Mexico, West Indies, and South America are the regions whose flora has been substantially augmented during the past year.

Mounting and Insertion of Specimens.—The mounting of herbarium specimens has continued uninterruptedly throughout the year. This important phase of herbarium work has been carried forward mainly by Miss Violet Bauer. The total number of specimens mounted during the year approximates 17,000. This represents the entire lot of specimens received on accessions in 1944 plus a considerable amount of material accumulated in previous years.

The insertion of the major portion of this newly mounted material in the organized herbarium has been done by the Curator, assisted by Mrs. Nettie Mae Bauer. Because of the congested condition in many parts of the herbarium, the interpolation of additional specimens has become almost impossible without serious injury to the plants from overcrowding. It has been necessary, as in 1943, to place in temporary storage certain groups of plants particularly ferns, conifers, and grasses. However, through judicious moving of the monocotyledonous families it has been possible to gain sufficient space in the cases to accommodate for the present the entire collection of grasses. It is imperative that additional cases be obtained at the earliest possible date.

An important corollary in the routine work of the herbarium for many years has been the rearrangement of specimens within the family in accordance with standard floras, critical studies, and monographs. Numerous older specimens, particularly those acquired with the Bernhardi Herbarium, were placed many years ago in the general collections without adequate data. Oftentimes only a number accompanies the specimen. A careful search through the literature, however, enables one to amplify the label and to give the essential data to render the specimen of scientific value. This work

has revealed literally hundreds of historical types. Several families, including many of these older collections, have been reviewed and reorganized during the past summer by the Curator, assisted by Mrs. Nettie Mae Bauer and Miss Mary Potter Love. Some of the families so studied during July and August are as follows: Cistaceae, Dilleniaceae, Flacourtiaceae, Geraniaceae, Malpighiaceae, Polygalaceae, Rhamnaceae, Turneraceae, and Violaceae.

Exchange.—The exchange of duplicate specimens is always a very satisfactory way of building up an herbarium. During the past year about 5000 specimens have been received on the basis of exchange; and 2580 duplicate specimens have been sent to institutional herbaria and individuals with whom the Missouri Botanical Garden Herbarium for many years has maintained exchange relations.

Use of the Herbarium.—Although there have been somewhat fewer visiting botanists than in former years, yet the herbarium has been in constant use by members of the staff, graduate students, and specialists. It is of interest to note that the plants which have been in greatest demand for reference are the economic plants, particularly those which produce rubber, quinine, insecticides and insect-deterrents.

The requests for loans of special groups of plants for detailed studies have kept fully apace with former years.

Groups of plants under Special Investigation and Floristic Studies.—Certain groups of plants have received special study during the year. Among these are the lichens by Dr. C. W. Dodge; Apocynaceae and Asclepiadaceae by Dr. R. E. Woodson; Compositae by Dr. J. M. Greenman; *Psilostrophe* and *Schkuhria*, by Mr. Charles B. Heiser, Jr. Intensive studies of the Panamanian flora have been continued by Dr. Woodson in co-operation with Dr. R. W. Schery.

Statistical Summary (for the year ending December 31, 1944):

Number of specimens received during 1944:		
By purchase	1,970	
By gift	1,539	
By exchange	4,472	
By transfer	6	
By field work	4	
Total	7,991	
Number of specimens mounted and incorporated in 1944		17,256
Number of specimens carried forward from 1943		1,396,262
Total		1,413,518
Number of specimens discarded during 1944		198
Total number of specimens in herbarium		1,413,320

LIBRARY

In 1943 the Garden Library was so congested that there seemed scarcely

room for a year's book accessions. However, the year 1944 demonstrated that anything is possible. Not only were new books crowded in, but when the Office of the Board of Trustees moved into the old folio room at the Garden, space was found in the halls, reading room, and old lecture-room for the folios and periodicals. Of course, now the limit does seem to have been reached, for the office of the editor of publications is in the folio-reading room; one of the librarians has a space in the pre-Linnean section just large enough for her desk; and another is hemmed in between the pillars in the hall-way which serves as the serial section. Nevertheless, the routine work of the library is still carried on, and the moving of the hundreds of books and periodicals was accomplished, even as to labelling, in several days' time. Recently, a librarian from the Museu Nacional, Rio de Janeiro, Brazil, visited the Garden library. When she was being conducted through the various departments she remarked that the Museu Nacional had about the same number of books as the Garden, but not nearly so many serials or pamphlets. Then when she heard that we had only three members on our staff she was amazed, for her library had a staff of ten. Furthermore, of our three members, one is in charge of the editing of the Garden publications and another spends half time at the switchboard, so there is just one giving full time to library matters.

In order to plan intelligently for future needs of a new building some time in the future, a survey was made during the summer of the growth of the library. The present amount of shelf space was measured, the number of books and pamphlets acquired during an average year was tabulated, and from these data the space needed to allow for normal growth over a given period was calculated. At the same time certain recommendations were also made.

Besides the regular library routine much time of the library staff during the year was taken up with supplying information to the public. The most insistent calls have been for information about the plants of the Pacific Islands and the Orient. People with relatives or friends in the Armed Forces would ask what vegetables could be grown in a garden in northern India, what edible plants could be found in a certain Pacific Island, etc. Often there was no printed information about the plants of the particular locality, in which case the librarian would have to locate the nearest place of which there is a flora, or else a place with a similar climate. During one week the library received several calls for information about plants in a small group of islands near New Guinea which we have since learned was made into an important naval base. Some of the ex-students now in the Armed Forces have also been writing for books or information about the regions where they are located. One naval lieutenant, a former Garden research student,

left us a standing order to send him all new botanical books in his field or any work which deals with the South Pacific area. Another project in which the Garden helped was in the making of a large wall map for the reception room of a drug company. The idea was to paint the drug plant in the area where it grows. The library assembled good colored illustrations from which the artist could choose her copy and assisted the company researcher in checking the botany of the plant. Incidentally, this researcher spent the greater part of the summer in the Garden library.

During the year the library checked the entries for a forthcoming supplement to the 1943 edition of the "Union List of Serials." For this purpose a booklet containing a list of several thousand new or changed titles is sent to all libraries whose holdings are listed. If the institution had the serial its symbol (MoSB for the Missouri Botanical Garden) and the volumes or parts, with their dates, were inserted in the space beneath the title. Corrections and insertions from the last edition were sent in at the same time. The work was very laborious and time-consuming, but well worth the effort involved, as the "Serial List" keeps us aware of desirable or missing publications. It also is an invaluable aid in cataloguing, especially European serials whose titles often have changed many times.

Publications.—Volume XXXI of the quarterly ANNALS and Volume XXXII of the monthly BULLETIN were issued during the year. The volume of the ANNALS consists of 419 pages, 20 plates, and 131 text-figures. Among the papers were the third and last installment of Part II of Woodson and Schery's "Flora of Panama," including the Index to Part II, Anderson's five Maize papers, and three Master's thesis in taxonomy representing monographs of the genera Palafoxia, Psilostrophe, and Polygonatum.

The volume of the BULLETIN contains 197 pages, 27 plates, and 34 text-figures. The October number—Fairburn's report on "Gravel Culture of Orchids"—proved so popular that the Garden supply was practically exhausted in a month. However, the paper was promptly reprinted in three installments in *Southern Florist*, and in December Mr. Rodney Wilcox Jones, President of the American Orchid Society, had it reissued as a supplement to the Society's Bulletin. In September the Garden contributed the Schedule of Exhibits for the Greater St. Louis Victory Garden Harvest Show, and this was reprinted in the September BULLETIN.

The exchange relations between the ANNALS and South American journals has always been more or less unsatisfactory. It was felt that we were not receiving all the worth-while publications and that some of the institutions to which our ANNALS were being sent were not publishing things of equal value to us. This last year we took advantage of the fact that some of our ex-students are now engaged in rubber and quinine investigations in

South America and asked them to check our exchange institutions. The results verified our opinion. In two countries it was found that about one-fourth of the exchanges could safely be removed, some institutions having merged, others publishing nothing in our field, etc. However, the check showed that we had not missed any important publication. We still have not heard from some of the countries but expect to find the same situation there.

Until 1943 the Garden library sent ANNALS reprints annually to a representative list of botanists and institutions. Now they are sent only on request or in exchange, but about 550 were mailed out during the year. In addition to publications sent as exchanges, the receipts for ANNALS, BULLETINS, "Spring Floras," etc., in 1944 were $3,587.37.

New Accessions.—The English book catalogues are listing some very desirable things, but all too often the works are sold before our order arrives. Perhaps the most outstanding book received during the year was from South America—Descole's "Genera et Species Argentinarum." This is the first volume of an extensively illustrated folio work reproduced in a style as expensive and elaborate as some of the books of the early nineteenth century and seldom seen nowadays. Following are some of the other important purchases: Ainsworth and Bisby's A dictionary of the fungi. 1943; Arborists' News, Vols. 1-10. 1935-1944; Baxter's Pathology in forest practice. 1943; Burkhart's Las Leguminosas Argentinas. 1943; Cain's Foundations of plant geography. 1944; Farrer's Alpines and bog plants. 1908; Hagelstein's The Mycetozoa of North America. 1944; Hulten's Flora of Alaska and Yukon. 1941, and Flora of the Aleutian Islands and westernmost Alaska Peninsula. 1937; Seventh International Congress of Genetics held at Edinburgh. 1939; Jamieson's Vegetable fats and oils. 1943; Thomas Jefferson's Garden Book, 1766-1829. (Am. Philos. Soc. Mem. 22). 1944; Lindley and Hutton's Fossil flora of Great Britain. 3 vols. 1831-37; Martius' Prodromus florae Mosquensis. 1817; Muenscher's Aquatic plants of the United States. 1944; New Zealand Institute Transactions and Proceedings. Vols. 5-7, 1873-1875, and Vol. 9. 1877-1878; Paxton's Flower Garden, Vols. 1-3. 1853; Proceedings of the Philosophical Society of Glasgow, Vols. 11, 13, 14, 18. 1877-87; Raynold's report on the exploration of the Yellowstone. 1868; Rodgers' American botany—1873-1892. 1944, and John Merle Coulter. 1944; Salisbury's The reproductive capacity of plants. 1942; Saunders' Floral morphology, Vols. 1 and 2. 1940; Seckt's Flora Cordobensis. 1929-30; Smith's Marine algae of the Monterey Peninusla, California. 1944; Transit of Venus Expeditions. 1879; Webber and Batchelor's The citrus industry, Vol. 1. 1943.

Visitors.—In addition to the faculty and students in the Henry Shaw

School of Botany the following out-of-town visitors have made use of the library during the year: Mr. E. J. Alexander, Assistant Curator, New York Botanical Garden; Mr. Harold Arrowsmith, graduate student, Cornell University, Ithaca, N. Y.; Miss Helen Azevedo, Librarian at the Museu Nacional, Rio de Janeiro, Brazil; Dr. Gladys E. Baker, Assistant Professor of Botany, Vassar College, Poughkeepsie, N. Y.; Mr. Raymond Baker, Manager Breeding Department, Pioneer Hi-Bred Corn Co., Johnston, Iowa; Sr. Alejandro Bordas, of the Museo Argentina de Ciencias Naturales; Mr. C. N. Bowen, Assistant State Entomologist, Missouri State Department of Agriculture, Columbia; Miss Camilla Bradley of New Orleans, Editor of *Home Gardening;* Sgt. Louis G. Brenner, of the U. S. Engineers; Rev. Robert R. Brinker, O.F M., Instructor in Biology, Quincy College, Quincy, Ill.; Dr. Alexander F. Bucholtz, Bacteriologist, Pabst Brewing Co., Peoria, Ill.; Pvt. Karl Busch, of the U. S. Army; Dr. William L. Brown, Geneticist, Rogers Bros. Seed Co., Olivia, Minn.; Sr. Alcides Carvalho, Engenheiro-Agronomo, Instituto Agronomico, Campinas, Sao Paulo, Brazil; Lt. Robert B. Clark of the U. S. Army Air Forces; Dr. Delzie Demaree, Chairman Natural Science and Mathematics, Arkansas Agricultural and Mechanical College, Monticello; Dr. Andre Drefus, Professor of Biology, University of Sao Paulo, Brazil; Lt. Ralph W. Emons, of Majors Field Station Hospital, Greenville, Texas; Pvt. Dara E. Emery of the A.S.T.P. at the Missouri School of Mines, Rolla, Mo.; Dr. Ralph O. Erickson, Instructor in Botany, University of Rochester, N. Y.; Sgt. Cedric Flewellyn of the U. S. Army; Dr. George J. Goodman, Associate Professor of Botany, Iowa State College, Ames; Dr. George B. Happ, Professor of Biology, Principia College, Elsah, Ill.; Mr. Frank J. Heinl, Director Illinois State Horticultural Society, Jacksonville, Ill.; Dr. William E. Hoffmann, Director of Lingnan Natural History Survey and Museum, Lingnan University, Canton, China; Mr. Leslie Hubricht, of Norfolk, Va.; Mrs. Roy Arthur Hunt, well-known bibliophile of Pittsburgh, Pa., and Garden Literature Editor of *Bulletin Garden Club of America;* Mrs. James Hyde, of Oklahoma City, Okla.; Mrs. Jan Jansen of Sault Ste. Marie, Mich.; Mr. Adolph Jordahn, Superintendent Montgomery Palmetum and Fairchild Botanic Garden, Coconut Grove, Fla.; Lt. Hubert C. Keith of the U. S. Army Air Forces; Dr. Mary Maxine Larisey, Chairman Division of Science, Judson College, Marion, Ala.; Lt. (j.g.) Wayne Lenz of the U. S. Navy; Dr. L. N. Leonian, Professor of Mycology, West Virginia University, Morgantown, W. Va.; Lt. George J. Lindsay, formerly Director of the Desert Botanical Garden, Phoenix, Ariz.; Mr. John O. Lines, orchid grower at Piedmont Nurseries, Signal Mountain, Tenn.; Mr. Clint McDade of Piedmont Nurseries, Signal Mountain, Tenn.; Miss Elizabeth McSwain, graduate student in Botany, University of Arkansas, Fayetteville;

Dr. Rogers McVaugh, of the Division of Plant Exploration and Introduction, U. S. Dept. Agr., Washington, D. C.; Dr. Gustav Mehlquist, Instructor in Floriculture, University of California, Los Angeles; Corp. Fred G. Meyer of the Hospital Corps, Camp Ellis, Galesburg, Ill.; Lt. Reid Moran of the U. S. Army Air Forces; Sgt. Samuel French Morse of the U. S. Army Air Forces; Miss Violet Munger, teacher at San Domingo Day School, Bernalillo, N. M., member of the Cactus Society of America; Prof. Albert H. Musick, of the University of Tennessee School of Pharmacy, Memphis; Mrs. Merrill A. Newman, of San Mateo, Calif.; Miss Jean Nicholson of the Benvenue Laboratories (Penicillin), Bedford, Ohio; Dr. S. N. Ou, of the Department of Plant Pathology, University of Wisconsin, Madison; Lt. Bradford Pring of the U. S. Army Air Forces; Mr. George Proctor, graduate student, University of California at Los Angeles; Mrs. Edward Rodeman, of the Jefferson City Garden Club, Mo.; Lt. Frederick Russe, of the U. S. Navy; Professor Carl Sauer, Professor of Geography, University of California, Berkeley; Mr. Walter Scholl, orchid enthusiast, of Chicago, Ill.; Miss Kathleen Snyder, Assistant Editor, *Chemurgic Digest*, Columbus, Ohio; Mr. Hugh A. Steavenson, Manager of the Soil Conservation Nursery, Elsberry, Mo.; Mr. Henry N. Steele, Senior Agronomist and Administrator, Office Experiment Stations, Washington, D. C.; Lt. R. L. Steere of the U. S. Army Air Forces, former student in botany, University of Michigan, Ann Arbor; Dr. Charles D. Swingle of the Soil Conservation Service, U. S. Department of Agriculture, Petoskey, Mich.; Corp. (Dr.) W. L. Tolstead of the Med. Det., U. S. Army, formerly Instructor in Botany, University of Nebraska, Lincoln; Sr. Gino A. Tomo of the Facultad de Agronomia et Veterinaria, Buenos Aires, Argentina; Mrs. C. E. Van Barnevelt, of Chatsworth, Calif.; Mr. Frank D. Venning, research student in botany, University of Miami, Coral Gables, Fla.; Miss Ruth W. Webster, student of fossil botany, formerly of Coe College, Cedar Rapids, Iowa; Mr. George O. White, State Forester of Missouri; Pvt. Daniel E. Wonderly, of Fort Leonard Wood, Mo.; Mrs. Fleeta Brownell Woodroffe, Associate Editor *Better Homes and Gardens*, Des Moines, Ia.; Dr. Chi-tun Yung, Professof of Botany, Lingnan University, Canton, China; Mrs. Isabel Zucker, Garden Editor *Detroit Times*, Detroit, Mich.

The library also loans books on the interlibrary loan plan, 166 such loans having been made to 30 institutions during the year.

Statistical Information.—There have been donated to the library or received in exchange during the year 266 books valued at $740.15 and 1195 pamphlets valued at $242.37. There were 166 books bought at a cost of $700.94, and 22 pamphlets at a cost of $15.99. The library now contains 55,902 books, 92,343 pamphlets, and 353 manuscripts. The number of

index cards now totals 1,097,446, of which 5497 were added during the year, 963 having been written by Garden employees and 4,534 purchased at a cost of $104.48. One hundred and twenty-six books were bound and 10 were re-bound or repaired.

ANNUAL BEQUESTS

The annual flower sermon "On the goodness of God as shown in the growth of flowers, fruits, and other products of the vegetable Kingdom," provided for in the will of Henry Shaw, was preached at Christ Church Cathedral, on April 16, by the Rt. Rev. Karl Morgan Block, Bishop of California.

The Gardeners' Banquet Fund was used to provide turkeys for employees at Christmas.

ATTENDANCE FOR 1944

(Not including visitors to Arboretum)

	Week-days	*Sundays*
January	5,605	9,947
February	6,796	12,305
March	4,315	3,159
April	9,420	13,467
May	10,503	9,640
June	10,506	7,023
July	11,785	8,041
August	10,013	6,814
September	9,495	12,287
October	8,852	15,590
November	10,622	14,888
December	2,800	4,318
	100,712	117,479
		100,712
Total		218,191

GEORGE T. MOORE, *Director.*

Five of herd of thirteen deer which have established themselves at the Arboretum

THE MISSOURI BOTANICAL GARDEN

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National Horticultural Magazine

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Field Museum Notes

MISSOURI BOTANICAL GARDEN BULLETIN

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Volume XXXIII February, 1945 Number 2

Cover: *Dendrobium thyrsiflorum*, native to Burma.

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

Clumps of *Cattleya Trianae* (indicated by arrows) growing on a tree trunk fully exposed to the sun. Photographed in Colombia during the 1933 orchid expedition from the Garden.

Missouri Botanical Garden Bulletin

Vol. XXXIII FEBRUARY, 1945 No. 2

LIGHT REQUIREMENTS FOR ORCHIDS IN THE MIDWEST

DAVID C. FAIRBURN AND GEORGE H. PRING

For many years the relation of light to plant growth has been the subject of considerable scientific research and practical observation in the greenhouse and out of doors. Contributions from experiment stations and other sources have given us much valuable information on the light requirements of certain plants, but unfortunately very little of it pertains directly to orchids. So in most cases the orchid grower has had to rely on his own good judgment, inherited practice, or the trial-and-error method, to determine just how much light is needed for his plants. If one knew the natural environmental conditions for each type of orchid an attempt could then be made to duplicate these conditions as nearly as possible, and the problem would be much simpler. Apparently there is a trend in this direction, judging from recent articles that have appeared in various orchid publications. Growers in Australia are becoming increasingly aware of the value of abundant sunlight as compared to the usual methods of shading practised in Europe. The writers hold the opinion that many orchid collections in the United States are overshaded.

To manufacture the sugars, proteins, organic acids, fats, etc., that are absolutely essential for normal growth, plants must have a sufficient amount of sunlight; otherwise they suffer from malnutrition and eventually collapse. Furthermore, it has been conclusively demonstrated that flower production in many kinds of plants may be increased or reduced by regulating the amount of available daylight. Generally speaking, the flowering plants require far more sunlight than those raised only for foliage.

Although the light requirements of orchids have not been extensively studied in this country, undoubtedly most orchids need a certain amount of direct sunlight for normal growth and flowering. But how much? Considering the various geographical and climatic factors involved, it is apparent that no one set of rules will apply here. Orchid growers in different parts

of the country must rely on their own experience to find out the optimum amount of sunlight for their plants. The data in this paper are concerned mainly with St. Louis and the Midwest, but it is hoped that the facts presented will have far wider application.

RESPONSE OF ORCHIDS TO SUNLIGHT IN THEIR NATIVE ENVIRONMENT

On several collecting trips to Central and South America the amount of sunlight orchids receive in their natural state was carefully observed. Of course, conditions vary greatly, but as a rule exposure to the sun is determined by altitude and specific location of the plants on trees, rocks, etc. Orchid growers repeatedly ask why imported Cattleyas of the same species show such a wide variation in growth habits; some having short, stout pseudobulbs and short rounded leaves, while others have long, thin pseudobulbs and long narrow leaves. This difference is definitely associated with light intensity; the short, sturdy plants having grown in an exposed, sunny location, whereas the long-leaved plants developed in a protected, shady spot. In the tropics Cattleyas that receive the maximum amount of sunlight have yellowish-green leathery leaves which break easily when bent. Plants growing in shaded areas have dark green leaves that bend without snapping. But most important is the fact that *plants exposed to abundant sunlight produce far more flowers than those in shade.*

It is of course impossible to say definitely the amount of light orchids in general receive in their native habitat. However, with the Cattleya group full sun until about 10:00 a. m. and after 3:00 p. m. is common. During mid-day when the sunlight is very intense, the spreading branches of tropical trees provide shade. It is not unusual, though, to find certain Cattleyas, Oncidiums and Epidendrums growing in completely exposed positions. Cattleyas have been observed growing on rocks where they have developed from seedlings and have become accustomed to the strong noonday sun. All plants exposed to such conditions were very short, stubby, and had extremely fibrous leaves. Experiments at the Garden have produced similar growth responses.

Some interesting observations were made while collecting orchids in Panama and Costa Rica. At sea-level Schomburgkias were found in the tops of trees fully exposed to the sun. *Cattleya Deckeri* was often growing in full sun. *Cattleya Skinneri* was seen perched on tiled roofs of native houses in Costa Rica. Peristerias, which occur nearly at sea level, are terrestrial in habit and grow in exposed positions in association with tall grasses. Plants of these same genera in shaded areas produced considerably fewer flowers. Epidendrums, particularly the "non-bulbous" kinds, grow wild along

the hedge rows in Colombia in full sun. A half-acre of *Epidendrum radicans* in full bloom on a rocky area exposed to intense sunlight was particularly impressive.

Although certain species of orchids grow well in exposed positions, it is fatal to move them from a shady location directly into full sunlight. On a collecting trip in the Chiriquí region of Panama a fine specimen of Warscewiczella was found on a small tree about twelve feet from the

Cattleya Mossiae recently imported from Venezuela, showing typical growth habit of plants found in exposed positions on tree trunks as illustrated in pl. 4.

ground and was moved to a convenient place near the trail. Unfortunately, upon returning three days later it was found burned almost beyond recognition—simply because it had been accustomed to the shade of a tree during mid-day. This same condition can easily be obtained in greenhouses if the shading schedule is not properly handled.

An orchid collector is indeed fortunate if he comes upon an area which the natives are clearing in preparation for establishing a coffee *finca* (plan-

tation). Climbing over the felled trees usually nets a considerable harvest of "botanical" orchids. However, it is necessary to work fast because when the trees fall most of the plants which had been shaded suddenly find themselves faced with the prospect of a third-degree sunburn. Three or four days is usually the limit of their endurance. In one of these felled areas an orchid collector from the Garden discovered the first epiphytic Lady-slipper, *Phragmopedilum caudatum*, growing on a tree which shaded it from the mid-day sun. Later, specimens were found planted on large rocks in the garden of a native, who had brought them from a *finca* clearing. They had been there for two or three years and apparently had adapted themselves to direct sunlight. The small green Lady-slipper, *Phragmopedilum longifolium*, is definitely terrestrial, and favors moist rocky ledges in ravines, where it receives only a minimum of sun. *Odontoglossum Powellii*, *Trichopilia suavis*, Stanhopeas and Lycastes were all collected in the Chiriquí region where they thrived in shaded locations. In all cases the foliage was dark green, except in *O. Powellii*, which had slightly glaucous leaves.

Another good example of response to sunlight was obtained with plants of Renanthera which were taken from St. Louis to the Garden's Tropical Station. They were placed on a non-deciduous tree, and had considerable shade because the shoots grew right up the trunk. Within two years they were well established and everything was fine except that there were no flowers. Later, other Renanthera plants were attached to a leguminous tree that dropped all its leaves once a year. Here they made rapid growth during the time when there was shade; then, when the leaves dropped off the tree, growth was retarded, the green color changed to yellow-red, and flower spikes soon appeared.

Vanda teres and its hybrid "Miss Agnes Joaquim" rarely flowered at the Garden in St. Louis, so cuttings were sent to the Tropical Station where they would have more favorable conditions. They were planted in pots and raised in a slat house. Growth was excellent, but no flowers were produced until the tops protruded through the roof. Since no flowers appeared on the parts of the plants under cover, it was evident that additional sunlight was needed. Subsequently, the Vandas were planted at the foot of some Royal palms. Attaching themselves to the trunk and having plenty of sunlight, they grew rapidly and flowered regularly every summer. According to Kirch (6), the hybrid *Vanda* "Miss Agnes Joaquim" is grown by the thousands for cut flower purposes in open field plots in Hawaii; and in Florida it has been reported growing outdoors the year around.

Following the information on light requirements obtained in the Canal Zone, the Renantheras and terete Vandas at the Garden were moved to the

Cattleya Mossiae with slender growth, typical of plants found in shady positions.

Imported *Cattleya Mossiae*, showing short stubby leaves and pseudobulbs characteristic of plants growing in exposed locations in the Tropics.

south-gable end of the greenhouse where they receive the major portion of sunlight. In this location they now flower annually. A similar response to additional light was obtained with a house of *Cattleya gigas* and its hybrids raised from seed at the Garden, many of which had a tendency to come "blind." Recent observations on *Cattleya gigas* growing naturally in Colombia definitely indicated that it, like the Brassavolas, requires more sunlight than most Cattleyas to produce free flowering plants. This has been well demonstrated at the Garden during the past three years, flower production having been doubled merely by increasing the amount of available sunlight. The typical red tint on the leaves and pseudobulbs in spring is a good indicator of the amount of sun needed to bring forth flower spikes equal to those seen in Colombia—five to seven flowers from each new growth. Species and varieties of Dendrobium and Cymbidium also respond well to considerable sunlight, but in Missouri the light intensity has to be reduced to avoid excess heat in the greenhouses during summer.

CONTROL OF LIGHT IN THE GREENHOUSE

From these experiences with light exposure in the tropics it would appear that orchids in greenhouses located in the temperate regions could be grown to better advantage if they received more sunlight than many growers deem advisable. To determine the optimum amount of sunlight needed throughout the year in the Midwest, intermittent meter readings have been made for the past six years, both in the orchid laboratory at the Garden and in the growing range at the Arboretum, thirty-five miles outside the limits of St. Louis.

Preliminary tests with the usual photometer indicated the necessity of an instrument with a greater range to measure intense sunlight on clear days. A Weston Illumination Meter, Model 603, was purchased and has been used for over five years with satisfactory results. This instrument is calibrated in foot candles with possible readings up to 10,000. When readings were over 10,000 foot candles, approximate estimates of intensity had to be made. There are so many limiting factors associated with the intensity of sunlight that any data recorded on an intermittent basis are subject to frequent discrepancies. To reduce error to a minimum, numerous readings were taken at different hours of the day, under various weather conditions, and during every month of the year. A complete record of these readings would fill too many pages; besides, the fluctuations from day to day and hour to hour would present a rather confusing picture to anyone not familiar with this type of work. Table I summarizes the results of tests made in an east-west, even-span greenhouse (75′ x 21′ with a roof pitch of 27 degrees) having

Cattleya Trianae from Colombia, growing in a 6-inch pot, carrying 10 flowers after exposure to 30 per cent light.

Cattleya "Eleanore" (*C. Hardyana x C. gigas*) raised at the Garden from seed and bearing 8 flowers on one spike. Without exposure to strong sunlight in winter and summer *C. gigas* hybrids would have a tendency to come "blind."

standard glass 16" x 24" with a ¼" lap. The object of these tests was to learn how much direct sunlight orchids of the Cattleya group could stand without burning. Confidentially, this turned out to be quite an endurance contest between the plants and the greenhouse attendant, with the latter forced to retire frequently to the head-house during the summer for a bit of extra shade and a cool bottle of Coca-Cola.

TABLE I

MONTHLY AVERAGE OF LIGHT READINGS TAKEN AT NOON ON CLEAR DAYS FOR A FIVE-YEAR PERIOD, BEGINNING 1940

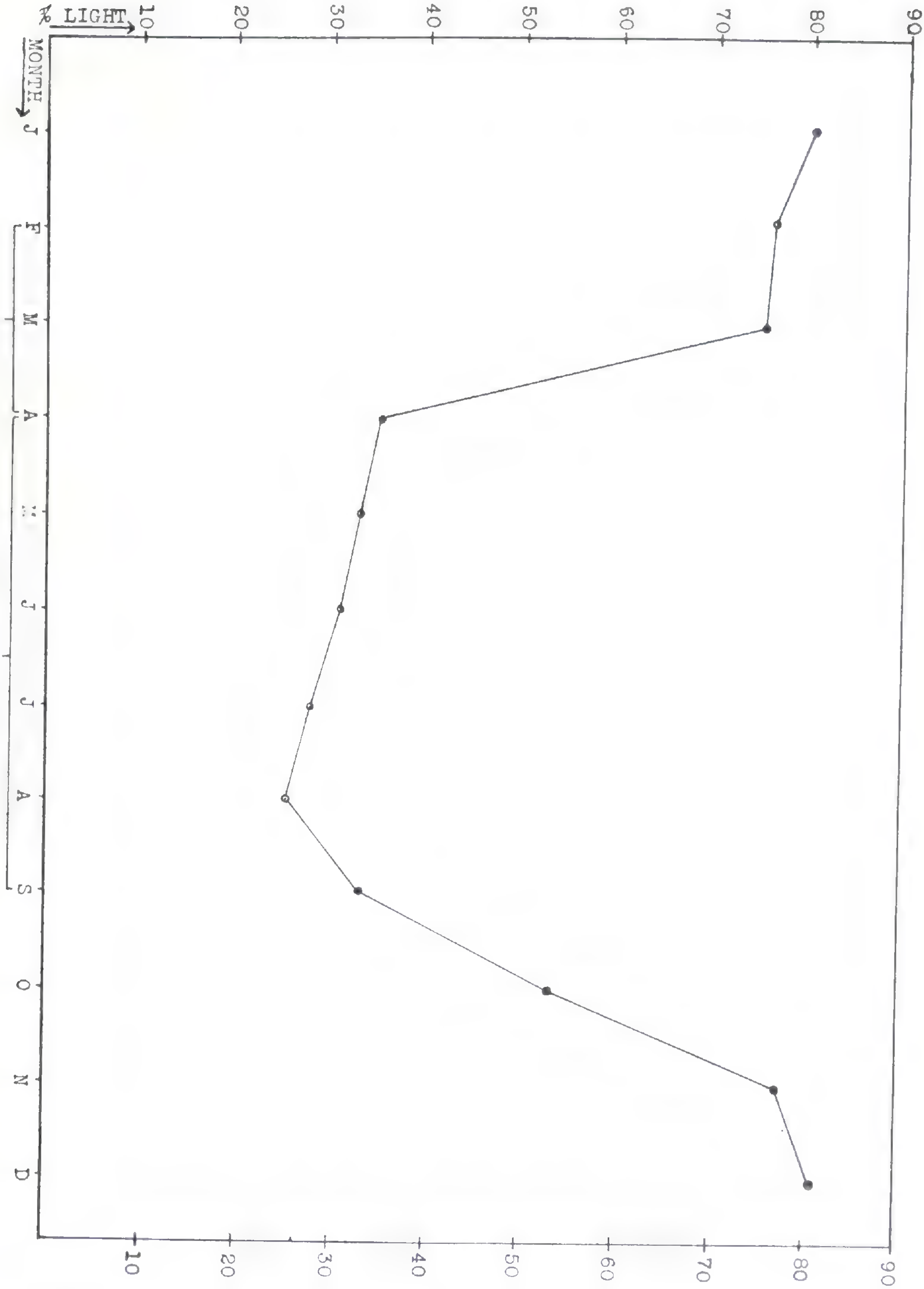
Month	*Outdoor reading (foot candles)*	*Greenhouse reading (foot candles)*	*Percentage of light entering greenhouse*
January	10,240	8,200	81
February	11,000	8,375 †	76
March	11,200	8,450 †	75
April	11,350	3,970 *	35
May	11,375	3,750 *	33
June	11,388	3,490 *	31
July	11,800	3,300 *	29
August	11,666	2,914 *	26
September	10,833	3,666 *	34
October	10,700	5,700	53
November	9,700	7,500	77
December	9,833	8,000	81

† Light skim of white shading needed on roof glass.

* Summer shading required.

The percentage of light in Table I, when graphically illustrated (fig. 1), clearly indicates the shading schedule needed for orchid houses in Missouri.

The sharp drop in percentage in April reflects the type of weather that may be expected in St. Louis at this time of year. Usually, a rather sudden change from winter to almost summer conditions occurs, with very little moderate spring weather, making it necessary to apply considerable shading to avoid sunburn. If the change were more gradual, the summer shading could be applied to the roof glass at least a month later.


% LIGHT
10
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30
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60
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80
90
MONTH
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A
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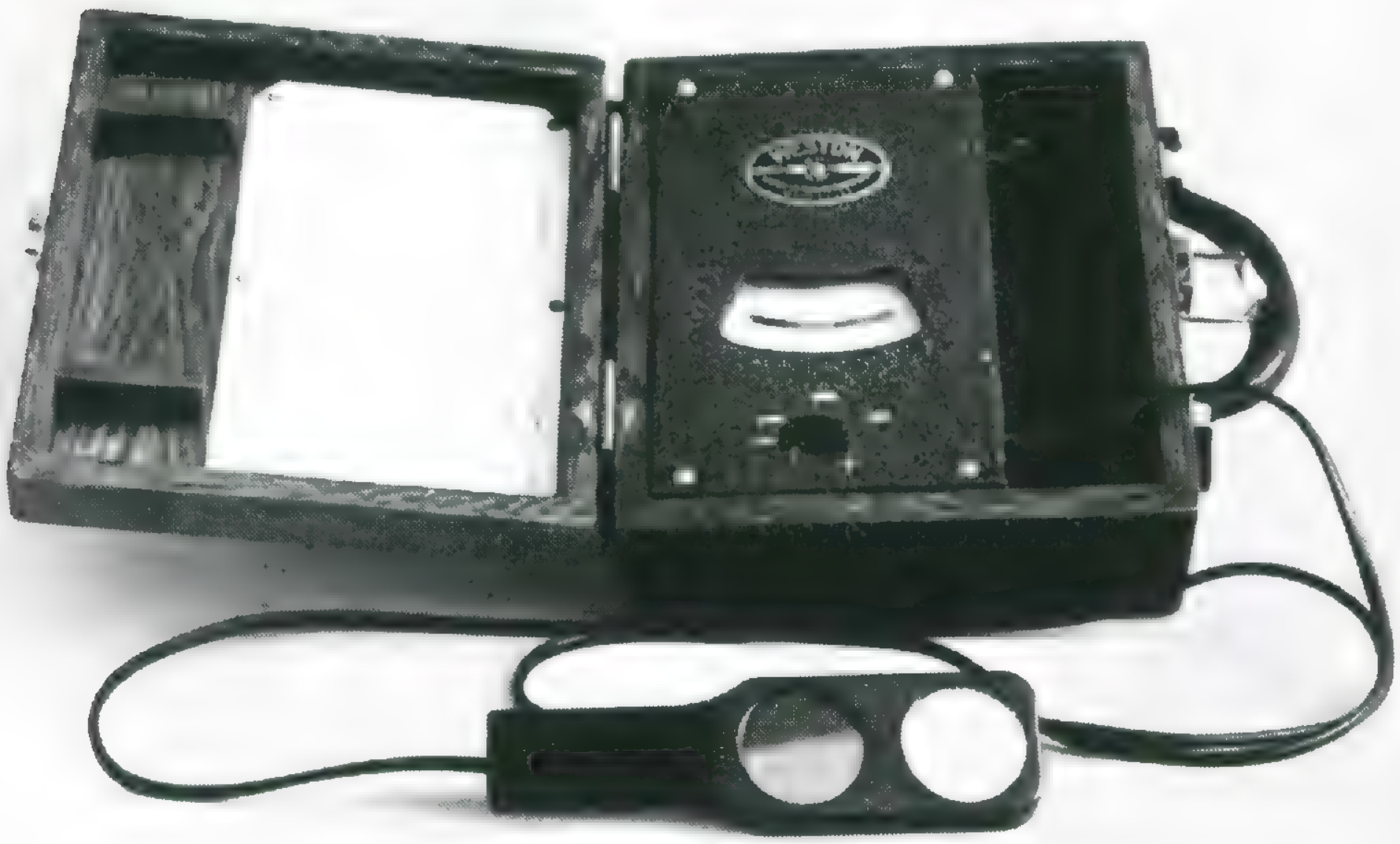
N
D
LIGHT SHADE
SUMMER
SHADE

Figure 1

Although the data in Table I were all obtained when the sky appeared perfectly clear to the eye, the intensity of the sunlight varied considerably from day to day, making the average of many outdoor readings lower than might be expected, particularly in midsummer. In St. Louis the intensity



Meter used for light readings in these experiments

undoubtedly reaches 15,000 foot candles many times during July and August, when the sun is really "bearing down," but accurate readings of such magnitude were beyond the range of the light meter used in these experiments.

From October to March the light intensity outdoors is higher than is generally realized, but at this time of year the sun's rays strike the north temperate zone at an oblique angle and do not possess the same quality or wave length as in summer. Consequently, the meter readings may be relatively high in the greenhouse with orchids showing no sign of sunburn. From April on through September, however, it would be disastrous to admit 80 percent of the sunlight into the greenhouse. Even if the orchids could stand the light, the heat would be unbearable. As indicated in Table I, a very thin skim of shading is usually necessary on the south side of east-west houses in St. Louis about the latter part of February, especially when Phalaenopsis, Cypripediums, and the albino forms of Cattleyas are grown.

In north-south houses protective shading would not be needed until about the latter part of February. Starting in October the white shading gradually weathers off, leaving the glass relatively clear during November, December, January and most of February. Of course, small seedlings and culture flasks would require a bit more shade than mature plants to encourage a softer, quicker growth.

Only two isolated cases of sunburn occurred in the house where the readings in Table I were taken. They were caused either by defects in the roof glass or by a weak spot in the white shading. A bit of extra shading applied to the glass eliminated this trouble.

Undoubtedly, *Cattleya Skinneri, Cattleya gigas*, and the hybrid Brasso-cattleyas could stand exposure to more sun than indicated in Table I. Up to a certain point an increase in light intensity speeds up photosynthesis, but the available supply of carbon dioxide in the air is relatively small, thus placing a restriction on growth and making additional light useless. If the carbon dioxide supply is increased by artificial means, more light can be used effectively. Experiments at the Garden have shown that orchids respond favorably to such treatment, but the present cost of bottled carbon dioxide precludes its use on any commercial scale.

The sunlight received at the earth's surface varies from time to time in duration, intensity, and quality. Duration or length of day changes with the seasons and with latitude. Intensity varies according to the distance and position of the earth from the sun and is materially affected by the amount of dust and water vapor present in the atmosphere. Quality differs with the seasons and the time of day. It is also claimed that the quantity of heat and light given off by the sun is not constant, variations of 2 to 3 per cent having been reported.

The influence of some of these limiting factors is evident in Tables II and III, giving typical light readings for winter, spring, summer, fall, and days with different types of weather conditions.

Obviously on cloudy days during winter the amount of light available to orchids in the greenhouse is not sufficient to maintain an adequate rate of photosynthesis. Prolonged spells of such weather cause a decided slump in flower production and general growth responses. In summer a similar condition occurs on cloudy days, especially with permanent shading on the glass. Roller blinds are ideal for regulating the light. According to the Eastman Kodak Sky Chart, type of daylight may be classified into four groups as follows:

1. *Bright sun.* Clear blue sky, strong shadows.
2. *Hazy sun.* Hazy sky, soft shadows.
3. *Cloudy bright.* No sun, some haze, no shadows.
4. *Cloudy dull.* No sun, no shadows, threatening sky.

TABLE II

EFFECTS OF SEASONAL WEATHER CONDITIONS ON LIGHT INTENSITY OUTDOORS AND IN THE GREENHOUSE

(Average readings for clear days measured in foot candles)

Hour (Standard time)	*February*		*May*		*August*		*November*	
	Out	In	Out	In*	Out	In*	Out	In
8	3000	900	7000	1300	10000	2000	3500	1300
9	6000	3000	9200	2000	11000	2500	8000	4500
10	10000	7000	11200	2700	12000	3300	9600	7000
11	11000	8700	12000	3000	12000+	3500	10000	7800
12 (Noon)	11500	9500	12000+	3200	12000+	3600	10500	8300
1	11000	8900	12000+	3300	12000+	3600	9900	7760
2	11000	8900	12000+	3300	12000+	3600	8300	5000
3	10200	7800	12000	3000	12000+	3500	5000	3000
4	8900	4800	9400	2100	10000	2300	2000	1000
5	1500	450	9000	1900	9000	1800	Sun down—too dark for readings.	

* White shading on roof glass.

In summer the roller blinds should be down only when bright sun prevails, or when the threatening sky of No. 4 includes the possibility of hail.

Other factors that have an important bearing on the amount and distribution of light in a greenhouse are:

1. *Direction of house.*—Considerable difference of opinion exists regarding this matter. Sometimes an east-west house is recommended in preference to one running north-south, in order to obtain the maximum amount of light during winter when the sun is low on the horizon. In the Midwest where the sunlight is very intense in summer, north-south houses are more desirable for temperature control and distribution of light. Even with north-south houses and heavy shading on the roof glass, orchids may be injured by extremely high temperature. This fact was well demonstrated at the Garden in 1936. During the summer of that year 75 per cent of the flower buds on *Cattleya labiata* and on Cypripediums were blasted; wire supports burned the stems of *Dendrobium nobile;* and such plants as Miltonias,

TABLE III

EFFECTS OF TYPE OF DAY ON LIGHT INTENSITY OUTDOORS AND IN THE GREENHOUSE

(Measurements in foot candles)

Hour (Standard time)	*Cloudy day in January*		*Clear day in January*		*Cloudy day in July*		*Clear day in July*		*Changeable day in July*	
	Out	In	Out	In	Out	In*	Out	In*	Out	In*
8	18	16	2800	600	1500	250	9800	1700	1800 (Cloudy)	300
9	250	100	5500	2700	2700	900	10700	2300	3500 (Hazy)	1100
10	500	300	9700	6500	3500	1150	11900	3200	12000 (Clear)	3000
11 (Noon)	1200	600	10500	8000	5100	1900	12000+	3400	6700 (Cloudy)	2300
12	1400	800	11000	8400	5000	1800	12000+	3600	12000 (Clear)	3300
1	1600	1000	11000	8400	4700	1450	12000+	3600	12000 (Clear)	3300
2	1000	500	10500	7600	6600	2000	12000+	3600	5000 (Cloudy)	1800
3	900	350	8300	5100	4200	1300	12000	3400	2600 (Cloudy)	750
4	350	150	7000	3500	1800	450	10000	2200	3700 (Hazy)	1100
5	30	15	400	70	2900	1000	8900	1700	8500 (Clear)	2300

* White shading on roof glass.

Odontoglossums, and Trichopilias, which are native to higher altitudes, were killed within a period of three weeks. Other tropical plants, for example Anthuriums, Adiantum fern, Cibotiums, and Bromeliads, were severely burned when the temperature in the greenhouse reached 115° F. If the houses had been facing east-west, the damage undoubtedly would have been greater. For additional information on the reaction of plants to high temperatures in the greenhouse refer to the Garden BULLETIN (Vol. 24, No. 7. 1936).

With the modernistic "skyscraper" type of greenhouse that was erected in Forest Park, St. Louis, all the light enters through the vertical tiered sides, reaching to a height of 50 feet. The necessary shade during mid-day in summer is provided by the horizontal roof areas covered with non-transparent, unbreakable material. Readings taken in this greenhouse showed about twice the light intensity of those recorded in the Garden's conservatories (Mo. Bot. Gard. Bull. Vol. 23, p. 163. 1935).

2. *Size of house and bench arrangement.*—Glass, of course, reflects light. Consequently as the sun shifts with the seasons the amount of light entering the greenhouse changes according to the angle at which the rays strike the glass. In winter the angle is wide and a good portion of the light rays bounce off the roof, especially with houses facing north-south. In summer, when the sun is directly overhead and more rays of greater intensity penetrate the glass, it is necessary to use some type of shade on the roof. The size of the house largely determines the pitch or angle of the roof, which in turn influences the amount of light rays transmitted through the glass.

At the Garden, medium-sized orchid houses (26′ x 100′) facing north-south have proved very satisfactory for the past nineteen years. These houses, equipped with concrete vaporizing tanks holding six inches of water and with flat wooden stagings on top, have given excellent results from the standpoint of relative humidity, temperature control, light distribution, and root development. The water in the tanks presents a large area for constant evaporation in summer and winter, thus helping to maintain the proper humidity. Water also has a stabilizing influence on the temperature in the greenhouses, since it does not heat up or cool off as quickly as the air. The moist cool air (especially in summer) over the water encourages vigorous root action. Aerial roots extend far out from the plants, growing along the stages and down into the water. Vandas become so firmly attached to the benches that it is impossible to move them without first severing the roots. Such root development is a fine example of the natural growth habit and should be encouraged as much as possible. The benches, being on one level throughout the houses instead of in the conventional staging arrangement, facilitate equal distribution of light to all the plants.

Although the light, moisture, temperature, and ventilation may appear uniformly distributed, it often happens that a certain plant or group of plants has to be shifted to several places in a greenhouse before a spot favorable to growth is found. This clearly indicates that conditions in a house are not always as well-balanced as one might expect.

3. *Condition of glass and type of shading used.*—In the city the accumulation of soot and dust on the glass reduces the amount of light available to the plants. In the absence of heavy rains and snow it is advisable to clean the roof with a hose, particularly during the short dark days of winter. Glass exposed to weather and city atmos-

Cattleya Trianae with leaves severely sunburned due to a sudden change from the semi-shade of the greenhouse to full exposure outdoors for one hour in July.

Dendrobium bigibbum, native of Australia, where it is grown in abundant sunlight. In Missouri this Dendrobium requires 30 per cent light in summer for free flowering.

pheric conditions gradually loses some of its transparency. It has been estimated that the deterioration amounts to about 1 per cent a year in the city. In the country, of course, glass remains clear much longer. Tests made at the Garden have shown that clean new glass transmits 5.3 to 11.2 per cent more light than glass that has been used for about ten years. The following readings taken at noon on June 8, may be considered typical:

Outside —11,500 ft. candles (full sun)
New glass—10,600 ft. candles
Old glass — 9,300 ft. candles

Estimates of the loss of light due to old glass, double glazing, lapping, etc., vary from 13 to 36 per cent. Tests at the Garden have shown too that clear glass is far superior to frosted glass for growing plants in the greenhouse.

There are two types of shading, permanent and movable. The latter type, provided by roller blinds, is most desirable from the standpoint of light efficiency and temperature control in summer. The initial cost of these blinds is high, but if handled properly they can be used for many years and are economical in the long run. On very large ranges they may not be practical unless they can be operated by machine instead of by hand. The standard orchid blind admits a certain amount of direct moving sunlight that is similar in many respects to the type of exposure orchids enjoy on trees in the tropics.

Originally, the orchid houses at the Garden Arboretum were equipped with roller blinds. When these were taken down for repairs, it was decided to try them spread out horizontally on the cross-bar supports inside the greenhouses (4 ft. below the ridge). For several years now this method of shading has been used and is desirable for the following reasons:

a. It provides optimum direct moving sunlight without injury from burning.
b. Between 11 a. m. and 2 p. m. in summer the center benches receive ideal light; in the morning the sun penetrates the blinds at an angle which provides the west benches with a good portion of direct light; in the afternoon the reverse condition exists, the east benches being given a "sun bath." Consequently, all parts of these north-south houses receive direct moving sunlight at some time during the day. To prevent burning the plants on the side benches, the lower halves of the roof (up to the blinds on the cross-bars) were covered

Summer position of orchid blinds inside the greenhouse.

Orchid blinds rolled up for late fall and winter.

with the conventional white shading.

c. In view of the strong sun in Missouri, these blinds are left unrolled from April to October inclusive. During the winter they are rolled up and left on the cross-bars. No white shading is used on the glass above the blinds at any time.

d. This method costs much less for operation and repair than when the blinds are placed outside. However, the temperature is a degree or two higher in the greenhouse with the blinds on the inside. Therefore, the edges of the slats should be kept one foot away from the roof glass to permit free air circulation at the sides, otherwise the temperature gets too high in July and August.

Some orchid growers recommend movable and stationary shades of muslin or cheese-cloth inside the houses. At the Garden we have found very little use for this type of shading. It does not permit any direct sunlight to fall on the plants and the muslin soon becomes black with soot.

On most orchid houses permanent white shading is used during the summer months. It is applied to the roof with a spray gun or put on lightly with a brush early in the season, with more added as the days become warmer. When only a few houses are involved it is advisable to scratch thin lines or stripes in this white shading to give the plants a certain amount of direct moving sunlight such as is obtained through the standard orchid blind.

4. *Type and age of plants.*—The amount of light entering the greenhouse must be adjusted, of course, to the recognized needs of the plants. Some orchids revel in sunlight that would be fatal to others; mature plants require stronger light than newly transplanted seedlings or those in culture flasks. It is surprising, though, how much sunlight the young plants can stand without showing any sign of injury.

5. *Flowering date.*—With commercial growers it is most important to have a good crop of flowers come in for special occasions, such as Christmas, Mother's Day, and Easter. By careful manipulation of temperature it is possible to retard or hasten flowering to some extent, so the question naturally arises: Can the blooming periods be further altered by proper regulation of light from the standpoints of duration and intensity?

It is well known that orchid species generally bloom only once a year at fairly definite times, while hybrids frequently have two flow-

Aerides and Anthuriums exposed to partial sun at noon (summer). Shaded area at lower right received similar exposure in the morning.

Bars of direct sunlight through overhead orchid blinds in summer cause no burning on shade-loving Anthuriums (*A. Veitchii* and *A. Warocqueanum*).

ering seasons at intervals of one to several months, the actual dates being quite unpredictable. Therefore, it would seem that the blooming periods of the species could be controlled more easily than those of the hybrids. The "botanical" orchids, however, do show considerable variation in time of blooming, and each kind might require segregation into early, intermediate or late flowering groups. For example, *Cattleya Trianae* at the Garden flowers all the way from November to March. Furthermore, production records for individual plants show that the blooming dates for *C. Trianae* vary as much as three weeks depending on prevailing weather conditions. An excellent example of this weather factor was obtained last fall when an extended period of clear warm days with brilliant sunshine forced *Cattleya Percivaliana* into full bloom three weeks ahead of normal time. The effects of this abundant sunlight carried over until Christmas, when the *Cattleya Trianae* plants produced an unusually large crop of flowers; and the *Laelia anceps* bloomed two to three weeks earlier than usual.

These preliminary observations clearly indicate that the duration and intensity of direct sunlight does influence the date of flowering, at least with certain species, and undoubtedly with many hybrids too. Experimental evidence on this subject, as well as on the use of artificial light, is being accumulated at the Garden.

Table IV gives a general idea of the light requirements of the more common types of orchids, including unflowered seedlings. Undoubtedly, growers in other sections of the country will find some of these recommendations at variance with their own experiences. That is to be expected, since the percentages given are primarily applicable to Midwest conditions.

Table IV, of course, deals in generalities only. In order to complete the picture it would be necessary to segregate species of certain genera, such as Oncidium, into all three light groups.

In addition to the light measurements taken in the greenhouses at the Garden, accurate data on the sun hours outdoors, both in St. Louis and at the Arboretum, have been recorded. A summary of these records for the past twelve years is presented in Table V.

TABLE IV

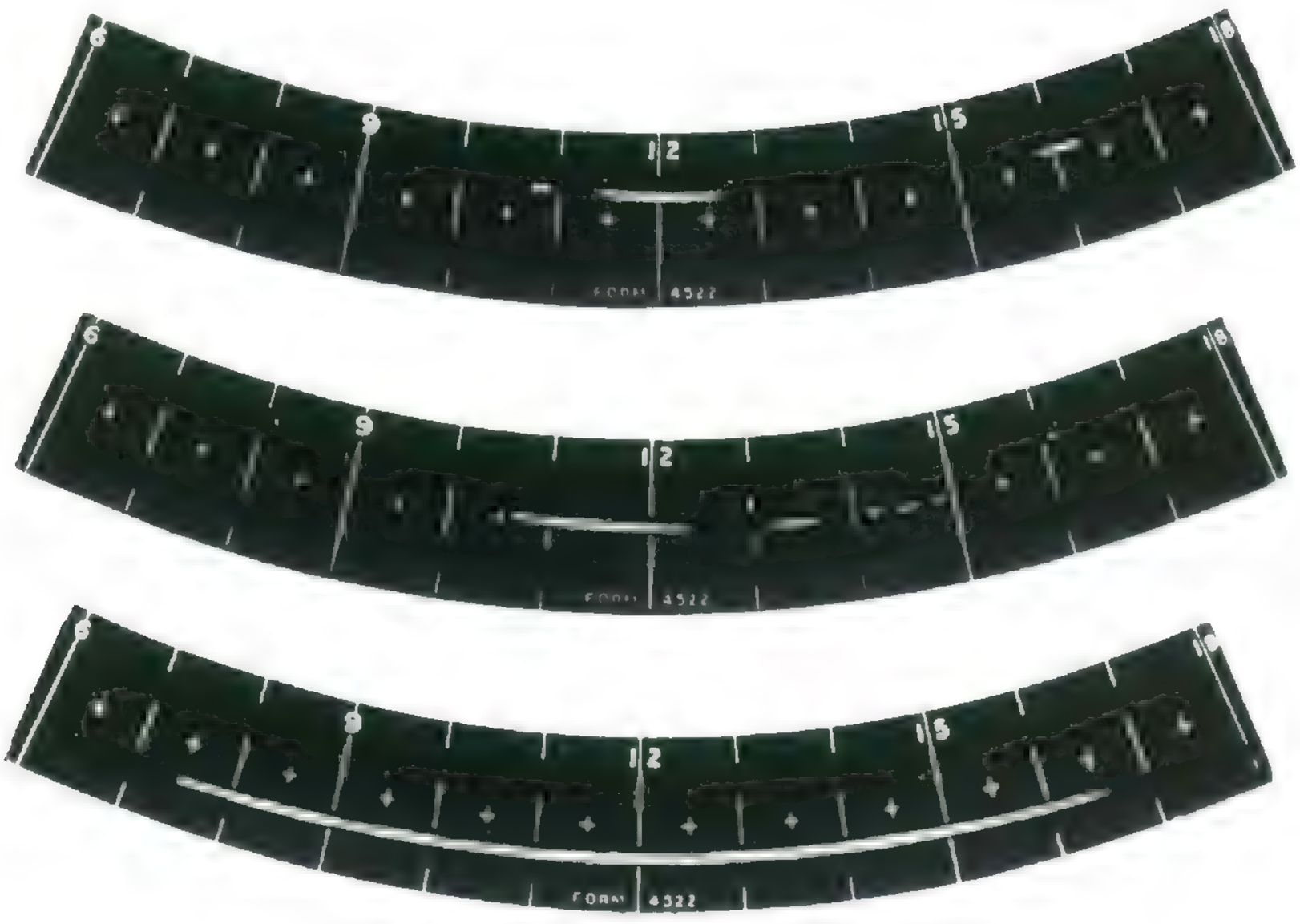
LIGHT REQUIREMENTS OF ORCHIDS IN MISSOURI DURING THE SHADING PERIOD FROM LATE FEBRUARY TO EARLY OCTOBER*

Light shade (*Some direct sun—20–30% of outdoor light*)	*Medium shade* (*Small amount of direct sun—15–20% of outdoor light*)	*Heavy shade* (*Little or no direct sun—10–15% of outdoor light*)
Brassavola	Aerides	Coelogyne
Cattleya gigas	Calanthe	Cypripedium
Cattleya Skinneri	Cymbidium	Miltonia †
Dendrobium nobile	Lycaste	Odontoglossum †
Dendrobium Phalaenopsis	*Oncidium Pouellii*	Phaius
Epidendrum radicans	Peristeria	Phalaenopsis
Laelia anceps	Saccolabium	Stanhopea
Laelia Boothiana	Sobralia	Trichopilia
Laelia purpurata	*Vanda tricolor*	Zygopetalum
Oncidium	All seedlings (1–2 years old, and albino forms)	Seedlings of above plants, and culture flasks
Renanthera		
Schomburgkia		
Phragmopedilum caudatum		
Vandas (terete)		
Seedlings of above plants (over 3 years old)		

* The rest of the year orchids can use all available light in the greenhouse without burning, even though this may amount to 75 or 85% of the outdoor intensity.

† Miltonias and Odontoglossums cannot be grown successfully in the Midwest.

Obviously, smoke and industrial haze are limiting factors when it comes to efficient light regulation in city greenhouses. The sad part about it is the fact that most of the smoke occurs during winter when orchids (and people) need all the sunshine they can get. Furthermore, the sulphur fumes that accompany soft coal smoke destroy orchid flowers, unopened buds, and even the leaves. Certain kinds of orchids, such as Phalaenopsis, Dendrobiums (particularly *D. Phalaenopsis*), Cattleya "Enid," and *Laelia anceps* are very susceptible to sulphur damage. When the smoke palls are heavy, all flowers except Cymbidiums and Cypripediums are ruined. To avoid these periodic set-backs to the Garden's rare orchid collection, the plants were moved to the Arboretum, far outside the city limits. Here they have made excellent growth, and the increased flower production has more than justified the transfer.



Charts used for recording sun hours. Burned areas indicate periods of full sunshine. Upper chart shows sun around noon and at 6 P. M. Center chart is characteristic of a changeable day with alternating sunshine and clouds. Bottom chart indicates sun from 7 A. M. to 7 P. M. Records obtained in October, 1944.

Crystal ball sunshine recorder for outdoor use. One of these is maintained at the St. Louis Garden and one at the Arboretum. Note the chart with burned streak.

TABLE V

COMPARATIVE HOURS OF CITY AND COUNTRY SUNSHINE

Year	*City garden*	*Arboretum*	*Difference*
1933	2242¼	2385	142¾
1934	2322	2503¼	181¼
1935	1879½	1962½	83
1936	2497½	2683¾	186¼
1937	2086	2289½	203½
1938	2304½	2496½	192
1939	2310	2498	188
*1940	2199	2304	105
1941	2197¼	2231¼	34
1942	2171½	2193¾	22¼
1943	2249¼	2423¼	174
1944	2141	2266	125
Average	2216¾	2353¼	137½

* City Smoke Ordinance adopted in 1940, resulting in a considerable decrease in the "difference" hours.

SUMMARY

1. Orchids in the tropics are exposed to more direct sunlight than is generally realized.
2. In their native environment, Cattleyas that receive the most sunlight produce the greater number of flowers.
3. The leaves are more fibrous and the flowers have better keeping qualities when plants are exposed to sufficient sun.
4. Red color on the leaves and new lead growths is a good indication of correct light for the Cattleya group. Albino forms generally require less sunlight than other Cattleyas, and practically none of them develop red color.
5. Optimum sunlight is essential for maximum flower production in the greenhouse.
6. Orchids that require only limited shade in summer should have 20–30 per cent of the outdoor light; those requiring medium shade, 15–20 per

cent; and the ones needing heavy shade 10–15 per cent. In late fall and winter the plants should have full exposure, which may amount to as high as 85 per cent of the outdoor sunlight intensity.

7. By regulating the duration and intensity of sunlight in the greenhouse, it might be possible to vary the normal flowering dates of many orchids.
8. A suitable illumination meter is essential for measuring light. It is impossible to make accurate estimates with the eye.
9. Roller blinds are the ideal type of shade for orchids. They provide from 25 to 30 per cent light intensity and at the same time admit a good portion of moving sunlight.
10. Greenhouses that face north-south are most practical in the Midwest.
11. Smoke and industrial haze reduce the amount of sunlight available in the city.
12. The amount of light reached in these experiments appears to be the optimum for orchids in the Midwest. It is probable that certain species and genera could be exposed to even more, but whether or not they would benefit from such treatment is another question.

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NOTES

Among the recent out-of-town visitors to the Garden were the following: Dr. Fred A. Barkley, Instructor in Botany, University of Texas, Austin; Miss Jean Nicholson, of Benvenue Laboratories (Penicillin), Bedford, Ohio; Dr. Ralph O. Erickson, Instructor in Botany, University of Rochester, Rochester, N. Y.; Dr. Walter Kiener, Ecologist Conservation and Survey Division, University of Nebraska, Lincoln; Pvt. Cedric Flewellyn, of the U. S. Army, formerly Gardening student at the Garden; Dr. Harry J. Fuller, of the United States Rubber Development Corporation, Georgetown, British Guiana; Mr. Anton Hogstad, Professor of Pharmacology, University of Grand Rapids, Grand Rapids, Mich.; Mr. Rudolph Pabst, orchid grower, of Winnetka, Ill.; Mr. H. W. Li, of the Rice and Wheat Improvement Institute of Szechuan Provincial Agr. Improve. Inst., China; Mr. C. R. Beckert and Mr. Godfrey Erickson, president and orchid grower respectively, of Thomas Young Orchids, Inc., Boundbrook, N. J.; Dr. and Mrs. Friedrich Eigenburger, orchid fanciers, of Sheboygan, Wis.; Mr. Robert Jones, Superintendent of E. W. McLellan Co., Orchid Growers, Colma, Calif.

A conference on "Gene Action in Micro-Organisms" was held at the Garden on February 2 and 3. The papers given, together with the proceedings, will appear in the April number of the ANNALS (Vol. 32, No. 2). Following is the program of the meetings:

FRIDAY, FEBRUARY 2ND

10:00 A. M.—Registration, Administration Building.

10:30 A. M.—Chairman, Dr. L. J. Stadler, University of Missouri.
"Mendelian and Cytoplasmic Inheritance in Yeasts"
Dr. C. C. Lindegren, Washington University
"Bio-Chemical Genetics of Neurospora"
Dr. G. W. Beadle and Dr. E. L. Tatum, of Stanford University

1:00 P. M.—Luncheon at the Garden.

2:00 P. M.—Chairman, Dr. C. F. Cori, Washington University School of Medicine.
"Genetic Aspects of Changes in *Staphylococcus aureus*, producing Strains Resistant to Various Concentrations of Penicillin"
Dr. M. Demerec, Carnegie Institution of Washington
"The Genetics and Physiology of Adaptive Enzyme Formation in Yeasts"
Dr. S. Spiegelman, Washington University School of Medicine
"The Use of Radiation for the Production of Mutation with Improved Fermentation".....Dr. A. Hollaender, U. S. Public Health Service

7:30 P. M.—Dinner, Informal, University Club.

8:30 P. M.—Chairman, Dr. A. H. Sturtevant, California Institute of Technology.
"Nucleic Acid Protein Interaction"
Dr. J. P. Greenstein, U. S. Public Health Service

SATURDAY, FEBRUARY 3RD

10:00 A. M.—Chairman, Dr. J. W. Gowen, Iowa State College.
"Gene Action in Paramecium"..... Dr. T. M. Sonneborn, University of Indiana
"Bacterial Mutations from Virus Sensitivity to Virus Resistance"
Dr. M. Delbruck, Vanderbilt University
"Genetics of Bacterium—Bacterial Virus Relationship"
Dr. Salvatore Luria, University of Indiana
"Genetics as a Tool for Studying Gene Structure"
Dr. Sterling Emerson, California Institute of Technology

1:00 P. M.—Luncheon at the Garden.

2:00 P. M.—Chairman, Dr. A. D. Hershey, Washington University School of Medicine.
Exhibits and Demonstrations.

4:30 P. M.—Tea.

The following out-of-town visitors attended the meetings: Dr. Edward H. Anderson, Vanderbilt University; Dr. G. W. Beadle, Stanford University; Dr. M. Demerec, Carnegie Institution of Washington; Dr. Max Delbruck, Vanderbilt University; Dr. Sterling Emerson, California Institute of Technology; Dr. David R. Goddard, University of Rochester; Dr. John W. Gowen, Iowa State College; Dr. Jesse P. Greenstein, U. S. Public Health Service; Dr. Alexander Hollaender, U. S. Public Health Service; Dr. S. E. Luria, University of Indiana; Dr. H. J. Muller, Amherst College; Dr. Kenneth B. Raper, U. S. Dept. Agr.; Dr. R. R. Roepke, American Cyanamid Co.; Dr. E. R. Sears, University of Missouri; Dr. J. M. Severens, University of Illinois; Dr. T. M. Sonneborn, University of Indiana; Dr. L. J. Stadler, University of Missouri; Dr. Curt Stern, University of Rochester; Dr. A. H. Sturtevant, California Institute of Technology; Dr. E. L. Tatum, Stanford University; Dr. P. C. Trexler, University of Notre Dame.

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MISSOURI BOTANICAL GARDEN BULLETIN

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

View down the valley from the upper story of Rila Monastery. *Hedera Helix* var. "MBG Bulgaria" was collected in the beech woods beyond the building in the foreground.

Missouri Botanical Garden Bulletin

Vol. XXXIII MARCH, 1945 No. 3

TWO BALKAN IVIES FOR ST. LOUIS GARDENS

EDGAR ANDERSON

After nearly ten years' exhaustive trials at the Missouri Botanical Garden two new hardy ivies of the English type are now ready for distribution to American gardens. Outwardly, even the expert will see little difference between them and the ordinary "English" ivies of the florist's shop or of old southern gardens. Inwardly, they are marked by a tolerance not only of severe cold weather, but of dry winters and hot summers. They can stand the middle-western American climate better than any variety yet introduced into cultivation; they make it possible to grow the true ivy *(Hedera Helix)* as easily in St. Louis as it has been grown in Virginia or Mississippi.

These new varieties did not just happen; they are the result of scientifically planned collections. In surveying plant materials available to eastern American gardeners there seemed a need for easily grown evergreens which would keep our gardens from looking bare and lifeless in the winter. Ivy, yew, and boxwood, which make an English garden glow with life during the winter, are difficult or impossible to grow north of Philadelphia and west of the Atlantic seaboard; nor are there other plants to take their places effectively over much of this area. A little reflection suggested why European ivies and boxwood might be difficult subjects in this area. Like many other plants, the strains of these evergreens which we grow in our gardens come from the same parts of Europe as did our ancestors, from England, Germany, and the Scandinavian peninsula. These lands have a severe winter, but one so different from ours that we really need a different name in describing it. The north European winter is cold and wet, never cold and dry, and it is followed by a cool summer with an evenly distributed rainfall. It is an area which does not have our common American experience of a brilliant winter day with the air clear as a bell, the sun shining brightly in a cloudless sky, and the temperature close to zero or below it. Small wonder that ivy, yew, and box from those parts of Europe have not succeeded in our gardens!

It accordingly occurred to me to inquire if there might be a part of Europe which had a climate like ours; a continental climate, hot in summer, cold and dry in winter, with a tendency to long droughts at any time of year. Such a climate is to be found on the Russian steppes, but in a very exaggerated form. A little to the eastward, in Rumania and Bulgaria and Yugoslavia, there is the nearest approach to our exact climate pattern. Omaha and Council Bluffs are very like Bucharest, Rumania, in their average monthly temperatures and total monthly rainfall. Furthermore, these Balkan lands have a rich and varied flora. Ivy, yew, and box are to be found growing wild in various parts of the peninsula. In 1934, therefore, I visited Rumania, Bulgaria, and Yugoslavia under the joint auspices of Harvard University and the United States Department of Agriculture, choosing by preference the sun-baked areas in the northwestern Balkans, which have cold, dry winters like ours. I attempted to collect seeds and cuttings of four interesting evergreens, holly, ivy, yew, and box, on the theory that, even though they looked more or less identical with these same species in northern Europe, they must be different on the inside. If they could grow in Cluj, Rumania, they should be able to persist over winter in St. Louis. If they were hardy in Skoplje in southern Yugoslavia, we might be able to grow them here with a little protection.

The hunch was apparently a good one. There can now be no doubt about the ivies. They are several degrees better than anything else for this climate. The boxwood is now being tried out at the Garden's Arboretum at Gray Summit. It is the most promising boxwood in the extensive collections there, but it will not be released until careful tests have shown just what it will and will not do. The holly is apparently a failure. Even in the Balkans it is found very rarely, and we were able to obtain seeds only from Sarajevo in Bosnia, where the climate is more like that of Little Rock, Arkansas, than it is like St. Louis. The yews seem to be a success, but they are slow-growing and it is too soon to speak with certainty about them.

In a way, however, even the ivies are not quite what we ordered. They have proven completely hardy in St. Louis for the past nine years, in the city as well as the country, but in very cold, open winters they are not completely evergreen. In four years out of five they hold their attractive dark green leaves till spring, but in an intensely cold winter with little or no snow cover the leaves begin to turn brown and fall off some time in January or February. By March most of them are brown, at least in part, and many of them have fallen. They were bred in a climate like ours and they have too much sense to attempt to persist under such conditions. The vines and the leaf buds are absolutely uninjured, however, and the new leaves come

Rumanian State Forest of Comarno, near Bucharest, Rumania. *Hedera Helix* var. "MBG Rumania" was collected among the trees at the right of the picture.

out with a great rush in the spring. By the middle of April the vines are beautifully covered with a close mantle of bright green.

To one who does not know and understand the differences between these Balkan ivies and other strains, they really look dead after a severely cold, open winter. More than one gardener has given them a disgusted look and said, "Well, those pet ivies of yours are a goner this time," only to find them lustier than ever when spring brought out the new leaves.

Aside from their hardiness and the speed with which they acquire new leaves in the spring, the two Balkan varieties which we are introducing differ only slightly from other varieties in the trade. On the whole, they have larger leaves, particularly when grown in rich soil. This is especially true of the variety from Rila, Bulgaria, which produces leaves almost the

size of a sugar-maple leaf when well grown. The two Balkan varieties are very much alike. "MBG Bulgaria" has more deeply lobed leaves on the average, and is particularly well adapted to growing under trees. "MBG Rumania" is a little shaggier looking and not quite so attractive as a ground cover; it seems to be slightly more tolerant of hot sun and dry winds.

The varieties are named for the localities where they were collected in 1934. "MBG Bulgaria" came from a roadside bank among beech woods below Rila Monastery at the foot of Mt. Rila in northwestern Bulgaria. "MBG Rumania" came from the state forest of Comarno, just south of Bucharest, Rumania. It was growing in rich oak woods at a sheltered spot in the great Danube plain, and came from a particularly vigorous vine which had grown high up in a tree and borne fruit. In both cases cuttings were made on the spot and were kept damp until they could be sent by air-mail to the John Innes Horticultural Institution in England, where they were rooted and finally brought to the United States.

At the Missouri Botanical Garden these and other European ivies have been under careful and increasingly severe tests since 1936. Varieties from six places in the Balkans and three from Sweden were set out at that time and compared with each other, as well as with extensive plantings of Baltic ivy and other English ivies in the mausoleum. As might have been expected, the Swedish varieties came through the winters fairly well, but were severely checked by hot summer weather so that in ten years they have scarcely held their own. The Balkan varieties, though they started as small plants, soon were growing rampantly and have survived such upheavals as replanting of shrubbery in the bed where they were started, and digging of a new service tunnel through the center of the collection. Three years later, when their general excellence was becoming apparent, a test planting was made under very severe conditions. The most unfavorable site in the entire City Garden was deliberately selected, a narrow strip between the east wall and the main pathway from the Main Gate to the Administration Building. It is a spot which is exposed to winter winds and summer sun, and it has proved a difficult spot in which to grow any kind of plant material. Strong, rooted cuttings of Balkan ivy were set out there, along with other hardy varieties, such as the Baltic ivy, for comparison. Most of the English varieties died out completely. The Baltic ivy persisted and increased, but not as rapidly as the varieties from the Balkans which now make a solid mat over the whole area. They are spreading along the wall in both directions and are beginning to climb up its face. During all this time they have had no special attention since they were set out. As a matter of fact, they have even been pulled up when the annual planting of morning-glory vines has been set out along the wall.

Now that their hardiness has been thoroughly tested in this area, the Garden naturally wishes to make these new varieties available to the general public as soon as possible. Fortunately, ivy cuttings are very easy to root, and a good stock can be built up from a single cutting in quite a short time. In a greenhouse with a propagating bench one of the easiest ways is to lay the vine down horizontally and cover it with damp sand, allowing it to root at the base of each leaf. When the roots are well established the plant can be cut up into several separate rooted cuttings. However, it can be rooted in plain tap water in a living room window, and for the home gardener the best procedure to build up a stock is probably to plant out the cutting during the growing season and then in late summer or early fall, before there have been severe freezes, to cut off all the long terminal shoots and to root them during the winter. They may be potted in good soil when well rooted, and further cuttings taken from them when strong new shoots have appeared.

In order that these hardy varieties may have a wider test and be available to those interested, the Garden has propagated a number of plants which will be distributed gratis to any of the "Friends of the Garden" group. A small rooted plant may be obtained by calling at the Main Entrance (Flora Place and Tower Grove) any week-day between the hours of 8:30 A. M. and 5:00 P. M. If it is not convenient to call, send 25 cents in coin or stamps and a plant will be mailed.

A word of caution seems wise before these new varieties are released. They do so well in this area that they might conceivably become a weed in an area just a little warmer than ours. For that reason, they should not be planted south of central Missouri. There is no need for them there since other varieties are hardy and if these new varieties escaped to the woods they might in time be as much of a nuisance as the Japanese honeysuckle has become throughout the South.

While these Balkan varieties have been found hardy enough to grow and increase in St. Louis without any special care, a little attention will keep them more attractive and make them increase more rapidly. They will do best if the ground has been well spaded up before they are set out in the spring or early summer, and if a light mulch of rotted leaves or grass clippings or similar litter is applied in June. A good thorough soaking with the hose once in every two weeks during dry weather will not only make them increase more rapidly, but will clear off the spider webs which sometimes become rather unsightly at that season. In establishing them as a ground cover, nothing is more useful than a small piece of bent wire such as a paper clip, a bobby pin, or an old-fashioned wire hair-pin. They hold the young shoots in place where they are wanted and if they are pushed down firmly, constrict the vine just enough so that rooting is encouraged.

GROW YOUR OWN STRAWBERRIES

PAUL A. KOHL

Strawberries have been scarce and high-priced the last two years, and present war-time conditions prevent any improvement in the supply. Even if victory should come in the next few months there would be no appreciable increase in plantings until 1946, which means that strawberries will not approach a normal crop until 1947 or 1948. In the spring of this year the strawberry plantings in the United States will have been reduced to 51 per cent of the ten-year average of 1934 to 1943. A field of strawberries should be planted each year if a good cropping system is to be maintained commercially, and it can readily be seen how impossible that is with help as scarce as it is at present. Lack of help at picking time and for maintaining the fields will also seriously curtail the crop.

All fruit crops have followed the strawberry in scarcity and high price since 1942, and a gardener with only a small plot of ground can do very little to increase his own supply. Fruit trees and the cane and bush fruits require much space, and while grapes might be grown the vines will not begin to bear until the third year. After considering the possibilities of the various fruits for the small garden, the choice must finally be narrowed to the strawberry as the only fruit which will produce a good crop within one year from the time of planting.

Strawberries are not difficult to grow. It can safely be stated that very, very few home gardeners have ever grown their own any more than they have ever "rolled" their own until now. Times have changed, and the strawberries which were so plentiful each year from January until June have almost disappeared from the market bench. Fifty plants set this spring will yield a good supply of berries for a period of two weeks in 1946, averaging about a quart or more a day. The actual yield will depend upon the soil, the variety, the spacing, the culture and the weather. Strawberries must be planted very early in the spring, in March or April. If planted in May, the runners get such a late start that the young plants do not have sufficient time to develop before frost. If the soil is in workable condition in March and the plants have been received from the nursery, they should be planted. Freezing weather will not injure them after they have been set.

Soil.—A good amount of humus should be spaded into the soil as early as possible and sand should be added if the soil is heavy. The bed should be well drained, and yet strawberries need an abundance of moisture during the growing season and particularly when the fruit is maturing. Drought periods will occur during the summer, and it is at these times that the

strawberry bed should be thoroughly soaked once or twice a week. This watering may be done at any time of the day, but morning or evening is preferred. If the soil contained vegetables or flowers in previous years, it is probably rich enough as strawberries require only a medium-fertile soil. If the fertility of the soil is low, a light dressing of a complete plant food should be spread over the soil before it is spaded. Chemical fertilizers applied to the bed when the rows become matted will cause burning of the leaves.

Varieties.—Any one intending to plant strawberries this spring should lose no time in ordering the plants. Shortages in good planting stock are developing, and it might be difficult to secure the varieties selected. In most catalogs there is usually a choice of about six varieties. When space is limited it is difficult to select just one variety and feel confident that it will produce a good crop the following year. A first choice could be "Premier," as it is widely planted commercially in Missouri and is an excellent variety for the home garden. It grows well and produces many runner plants. The berries are early, medium in size, of good color and flavor. A second choice could be "Senator Dunlap," which also produces many runners, withstands drought and cold, and yields a good crop of berries. Possibly a third selection would be "Blakemore," but it is considered more tart than either "Premier" or "Dunlap." "Catskill" is a large-berried, mid-season variety. "Aroma," "Chesapeake," "Fairfax" and "Dorsett" are still other varieties from which to choose.

Planting, spacing, cultivating and watering.—As soon as the strawberry plants arrive, open the package and examine the plants. Remove all black and decayed leaves carefully and see that the roots are moist. If the planting must be delayed, lay the plants in a shallow V-shaped trench in a sheltered spot, spread the roots and cover them with moist soil. If there are only a few plants they may be heeled-in for a few days in a box of damp sand or soil.

Make the rows 3–3 ½ feet apart and space the plants about 18 inches in the row. Carry the plants to the garden in a wet sack, newspaper, or a bucket of water, and do not expose the roots to the wind or sun at any time before the plants are set. Remove any large leaves before planting, and if the roots are long shorten them to four or five inches. If planted early, the leaves will be small but later in the season the large leaves should be removed to prevent excessive transpiration. Open the holes with a trowel, spread the roots and firm the soil. The collar of the plant should be at the surface of the soil and one must guard against setting the plant too deep or too high. If the central rosette of leaves is covered with soil the plant will rot, and if the plant is set too high it will dry out. If the center of any

A good strawberry plant.
Soil line showing proper depth to plant.

plant becomes covered with soil during a heavy rain, lift the plant at the first opportunity and bring it to the right level. When all of the strawberry plants are set, pour a little water around each one to settle the soil about the roots. Cultivate the soil every week or two to kill the weeds, and while doing this remove any strawberry flowers which may develop, to prevent any fruit from forming the first year. By July the runners will begin growing rapidly in all directions from the mother plants. A runner is about as thick as a piece of stout twine, and when about a foot long a rosette of leaves forms at the tip while at the same time the roots develop and take hold of the soil. Within a few days another runner goes forth from this daughter plant and so on they go, in leap-frog fashion, producing a new plant at every hop. The numerous plants which are produced in all directions by the mother and daughter plants soon become crowded, and it is then a little help should be given by spacing the plants six or more inches apart. Crowded plants will only choke each other and reduce the yield of fruit. As the

young plants push their roots into the soil in mid-summer they quickly become established if the soil is moist, but if it is very dry and hard during a drought period their growth will be checked. Some varieties produce more runners than others and by September some of the excess runner plants may be removed. This method of growing strawberries is termed the matted row system, each row becoming about two feet wide. Watering and weeding are the two essential operations during the summer.

Mulching.—Some mulching material should be obtained in the fall to be applied to the strawberry bed about the third week in November. When the temperature drops below 20° F. some injury might result, so it is a good practice to have the mulch on hand to spread over the bed to a depth of two to three inches as soon as cold weather is predicted. In this region Thanksgiving Day may be considered the dead-line for mulching plants for the winter. Wheat straw is about the best mulching material. The foliage of some ornamental grasses is also very good, as it is free from weed seeds. Leaves are not recommended because they mat, but if no other material can be obtained only oak or sycamore leaves should be used as they remain crisp and dry out quickly after rain or snow. Some of the mulch should be removed when growth commences in March. At that time of the year a mild spell of weather is often followed by a sharp drop in temperature, and it pays to replace some of the mulch when such a cold spell is threatened. A 3- or 5-tined hay fork is the best tool for applying and removing the mulch.

Picking.—This operation affords the most pleasure and it is difficult to resist picking the first berries before they are fully ripe. Morning is a good time to pick the strawberries, when they are still cool. At first they are gathered every second day but as the crop increases it should be harvested every day. Each strawberry should be picked with a quarter-inch of stem attached.

Renovating the strawberry bed.—After the first harvest the bed should be reworked by removing some of the crowded plants and large leaves. A complete fertilizer may then be applied between the plants. Thoroughly flush the leaves with water immediately after applying the fertilizer to minimize leaf burn. Weed, water, and mulch as in the first year, and a fairly good crop may be expected the second year. After the third year the bed should be removed, and if more strawberries are to be grown in future years new beds should have been started in other locations.

Pot-grown strawberries.—Strawberries are also available for planting in late summer, but these are pot-grown plants. They can be planted closer together as they do not make runner plants like those started in the spring. The harvest from the spring-set plants will be greater and the initial cost will be considerably less.

VEGETABLE GARDENING NOTES FOR 1945[1]

HENRY N. ANDREWS

Cauliflower in St. Louis.—Many home gardeners shy away from this table delicacy, believing that it is too difficult a plant to raise. However, excellent results were obtained at the Garden last year with Burpee's "Dry Weather" variety. Seed was sown inside late in February and the plants set out the latter part of March, although the first week in April would probably be safer in most years. No special cultural precautions were taken other than one application of Vigoro when the plants were set outdoors. When the heads started to develop the upper leaves were drawn up around them to prevent yellowing; in early July they attained medium size, were firm, white, and deliciously tender. Although this report is based on only one year's trial, it seems worth passing along.

A few notes on tomatoes.—This little innovation produced a truly spectacular yield of fruit in one of our gardens last year: Prepare "wells" for each plant about 8 inches deep and about a foot in diameter; spade and fertilize the soil at the bottom of the well and set out the young plants the last of April. This is early, too early you will say, but if a cold snap seems imminent it is a simple matter to cover the plants with a sheet of newspaper, the top leaves being only a few inches above the level of the ground.

The well should be filled in as the season progresses, allowing development of supplementary roots and thus increasing the water-absorbing surface. Try this with a few plants this season. Some varieties that proved especially productive last summer were: "Certified Marglobe," "Beefsteak," "Rutgers," and "Golden Jubilee." The last should be in every garden, the fruits being of good size, firm, of the best quality and excellent for either table or canning.

Leeks for winter storage.—If you enjoy creamed onions you will find leeks, prepared in the same way, even tastier. We have found both the common "Broad London" ("Large American Flag") and Vaughan's "Elephant" easy to grow and good keepers. The latter is a real giant and deserves the attention of every home gardener.

Seed may be planted outside in early spring, but preferably inside at an earlier date. If you have a hot-bed or space in front of a sunny window follow this procedure: In February start the seeds in a sandy soil in an 8-inch pot; when 2 or 3 inches high transplant the seedlings to shallow trays of soil, spacing them about an inch apart. In early to middle April set the plants out about 4 inches apart in the row, or 6 inches for the "Elephant" variety. If the row is prepared as a shallow trench when the seedlings are set

[1] All dates given in this article apply to St. Louis, Mo.

out it is a simple matter to hill them with soil later in the summer. Let them grow until late fall, then pull up and bury them about a foot deep in some convenient corner of the garden. Dig as you need them during the winter.

Corn in early July.—For a few ears of corn, a week or ten days ahead of your neighbor, try this: Plant seed, one to each 3-inch pot, during the first week in April. The pots should be placed in a deep cold-frame, allowing 12 to 14 inches for growth of the seedlings. Set them out in the garden about May 5. If the weather is favorable you may be harvesting at least by the first of July.

Try Broccoli this year.—There are very few of the early summer and late fall crops that will bring greater beauty to the garden and more culinary pleasure to the table than broccoli. All the seed companies carry the "Calabrese" ("Italian Green Sprouting") variety. Its culture is essentially the same as for cabbage and cauliflower. Sow the seed in a well-drained tray of soil indoors in late February. It is advisable to sterilize the soil in order to eliminate "damping off" fungi. This can be accomplished in the home simply by pouring a few quarts of boiling water over the soil. When the first leaves are well formed thin the seedlings to 3 inches apart. Set them out in early April, about 16 inches apart in the row. A large head will develop at the top of the stem in early summer. Cut the heads off but do not destroy the plants; side shoots will appear later and you should have an even better crop in the fall, although the side-branch heads will be smaller.

It is surprising how many people do not know that peeling the stems of broccoli before cooking adds greatly to the delicacy of its flavor. Start peeling at the cut ends of the stems and let the peel run off into the flower head. We have found 15 minutes to be ample cooking time. Longer cooking darkens the color and dissipates the fresh flavor. This holds for cabbage, cauliflower, and kohlrabi as well. Incidentally, dusts containing rotenone are amazingly effective (and non-poisonous) in controlling insect pests of these cabbage-family plants.

Sweet-potatoes for calories.—If you like them and want a heavy-yielding vegetable, do not neglect sweet-potatoes. For the average home garden plant two potatoes just beneath the soil surface, in a box of sand about 12 x 18 inches and 4 or 5 inches deep. Start them early in April. Put the box in a sunny window and keep the sand moist but not wet. Within three weeks an abundance of shoots will spring up from all sides of the potato. Have two or three other trays of sand ready, preferably a little larger. As the shoots attain a height of about 8 inches pull them off (a few roots will come along, too) and transplant to the other trays. The potatoes will continue to bud out shoots—50 or more from each one.

In the meantime, get the outside garden ready. Prepare a hill about 8 inches high and 1½ feet broad and as long as the row permits. If you plant more than one row allow 3½ feet between rows. Set out the young plants 18 inches apart; give them plenty of room for the vines are great spreaders. And now you can take the two stock potatoes, which will probably be about as firm as they were to begin with, and bake them for dinner!

An excellent soil conditioner—and cost zero.—On previous occasions we have advised, "Don't burn the leaves," but many gardeners still fail to take advantage of this source of organic soil conditioner. Two years ago one of the Garden's nurseries was converted into a victory garden. The soil was a rather heavy clay, hardening, like so many St. Louis soils, into an almost brick-like consistency during midsummer. On an area of one-half acre some 10 tons of partially decayed leaves (they had by no means reached the "leaf mold" stage, although this would be even better) were spread and plowed under in the fall. The soil showed some improvement the following summer, but when the process was repeated the second year gardening was a real pleasure. The soil was blacker, much more friable, holding an abundance of water yet workable within a day after heavy rains. Adopting this procedure for smaller gardens, about 1–2 bushels of partially decayed leaves for each 25 square feet should be sufficient for a season. The same results may, of course, be obtained with an abundance of manure but the cost of this is prohibitive for most home gardeners. Moreover, the winds of autumn do not ration leaves nor are they concerned with price regulations.

NOTES

Cinerarias will be on display in the Floral Display House at the Garden during the month of March.

Dr. Walter B. Welch, Assistant Professor of Botany, Southern Illinois Normal University, Carbondale, conducted a group of his students on a study tour of the Garden February 26.

The first number of Volume XXXII of ANNALS OF THE MISSOURI BOTANICAL GARDEN was issued in February, consisting of an installment of "Flora of Panama" (Part III, Fascicle 1), by Robert E. Woodson, Jr., and Robert W. Schery.

Recent visitors to the Garden include: Prof. Erling Dorf, Paleobotanist, Department of Geology, Princeton University, Princeton, N. J.; Chief Machinist Mate J. E. Whithington, of the U. S. Navy, formerly an employee at the Garden; Dr. Lloyd H. Shinners, Research Associate, Milwaukee Public Museum (on leave), Research Fellow, Southern Methodist University, Dallas, Texas.

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

WILLIAM TRELEASE—1857–1945

First Director of the Missouri Botanical Garden

Missouri Botanical Garden Bulletin

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WILLIAM TRELEASE

J. M. GREENMAN

The recent death of Professor William Trelease at the advanced age of 87 years removes from the ranks of living scientists one of the most widely known and prominent botanists of his generation. His long and active scientific career of more than 60 years is replete with achievement equaled by few in his profession. The most outstanding characteristic of the man was versatility. He was a stimulating teacher, a speaker of exceptional talent, a scientist of broad concepts, an original investigator, and an administrator of rare ability. William Trelease was born in Mount Vernon, New York, on February 22, 1857, and died in Urbana, Illinois, January 1, 1945.

His early education was obtained in the public schools of the East, namely, in the high schools of Branford, Connecticut, and Brooklyn, New York. From the high school he entered Cornell University and graduated from this institution in 1880 with the degree of Bachelor of Science (B.S.). At Cornell he received a broad training in language and in science. This training manifested itself in his many writings and addresses throughout his life. The post-graduate work of Trelease was done at Harvard University, and from this institution he received the degree Doctor of Science (Sc.D.) in 1884. His doctorate thesis concerned fungi, and the investigation was carried out under the direction of Professor William G. Farlow. An equal if not more important contact made by Trelease at Harvard was with Dr. Asa Gray. This contact resulted in the publication of "The Botanical Works of the Late George Engelmann," under the joint editorship of William Trelease and Asa Gray, 4to, 548 pp., *pls.* and *figs.* 1887.

The advancement of Trelease was rapid. In 1881-83 he was instructor in botany at the University of Wisconsin; 1883-84, in charge of the summer-school botany at Harvard University; 1884, lecturer in botany at Johns Hopkins University; 1883-85, professor of botany at the University of Wisconsin; 1885-1913, Engelmann professor of botany and head of the

Shaw School of Botany, Washington University; in 1889 the Board of Trustees appointed Trelease as Director of the Missouri Botanical Garden. This position he held with distinction until 1912. In 1913 he became professor of botany and head of the botanical department at the University of Illinois. In 1926 Trelease retired from active duties with the title of Professor Emeritus. From the date of his retirement until shortly before his death he continued taxonomic research on flowering plants, notably on the groups *Agave, Phoradendron, Piper, Peperomia,* and *Quercus.*

During all these years there was a continuous flow of contributions from the pen of Trelease; these cover a wide range of botanical subjects, constitute important contributions to scientific literature, and greatly enhance our knowledge of plants. A complete bibliography of his publications would approximate some three-hundred titles—much too long a list to be appended to this brief sketch.

Professor Trelease was the recipient of several honorary degrees, notably LL.D. from the University of Wisconsin in 1902; the University of Missouri in 1903; and Washington University in 1907. He held membership in numerous scientific societies both in America and abroad. In many of these he was not only an active member but served as president or in some other official capacity. He was secretary of the St. Louis Academy of Science from 1896 to 1903, and president from 1909 to 1912. He also took a prominent part in civic affairs and was chairman of the City Plan Commission of St. Louis from 1911 to 1912. In 1917 he was made chairman of the Illinois State Natural Resources and Conservation Board.

Professor Trelease was always a strong advocate of an intensive study of plants in the field. He made numerous field trips, participated in many scientific expeditions, and visited various parts of America and the Old World. One of the most important of the expeditions in which he participated was the Harriman Alaska expedition in 1899. On this expedition Trelease was concerned primarily with the fungi, hepatics, mosses, ferns, and fern-allies.

The esteem and high regard in which Professor William Trelease was held among his contemporaries is best shown by the many letters of congratulation and appreciation received by him from his friends, colleagues, and former students, in 1926, on the occasion of his retirement from active academic service at the University of Illinois.

RUBBER EXPLORATION IN COLOMBIA

PAUL H. ALLEN*

The Bajo Vaupes, like most frontier areas, is the gathering place of the selected failures and ne'er-do-wells of Colombia and Brazil, men who have gathered here after colorful careers ranging from larceny through laziness and hard-drinking to murder. Until the advent of the Rubber Development Corporation the region had been isolated in the extreme. It was either a sixty days' paddle from Mañaos, Brazil, or an equal period of unbelievable hardship through the unbroken forest and trackless *llanos* [rocky, mountain scrub vegetation] to the base of the eastern Andes, along the narrow track blasted from the precipitous wall of the river gorges and across the high, barren *páramos* [alpine meadows] to Bogotá.

The great meandering river [Rio Vaupes-Rio Negro], whose still reaches are broken by boulder-filled rapids and falls bearing long rhythmic names in Geral, has afforded the semi-wild tribes of native Indians a stoic but effortless existence, based on the exploitation of *Balata* or rubber. "Tribe" is used with reservation, for they are not distinct ethnologic groups such as the San Blas Indians of Panama, but are rather a homogeneous racial group of presumed Carib affinities, speaking numerous, more or less related dialects known under their Geral names of Tucano, Desano, Piratapuya, Ciriano, Yuruti, Carapana, Barasana, Tariano, Tatuyo, Cubeo, etc. They live in huge rectangular communal houses on the banks of the rivers or tributary *igarapes*, by preference above or near rapids or falls, where elaborate fish traps are planted to augment the diet of fariña and game.

A curious, possibly unrelated group, seemingly speaking several dialects, are those Indians known under the collective name of Macu. They are little better than slaves, and live in primitive huts in the forest away from streams. They have no agriculture but depend on game secured with blow-guns and curare-tipped darts. This existence is supplemented by Manioc roots taken in payment for labor performed.

The "Blanco" (a generic term here, meaning any one not Indian, even though coal-black) soon acquires an Indian squaw and sets about raising a half-wild troop of half-breed youngsters. If the Lord-and-Master feels that the lack of *aguardiente* has reached the point of desperation, he may be persuaded to lend his name and countenance to recruiting of related Indian

* Mr. Allen was formerly manager of the Tropical Station that the Garden maintained for some years in the Canal Zone. The following is the substance of a letter received in September of last year and relates experiences which seem to be more or less typical of thosé encountered by other former Garden students and staff members now engaged in the search for rubber and quinine. We hope to present in future issues of the BULLETIN additional chapters in this distinctive phase of American horticultural exploration.—Ed.

bucks, by his squaw, for exploitation of some forest product. The Indians are wheedled, considerably against their will, into accepting an advance or gift of merchandise, such as a trade gun, or cloth, or a *machete*, fish-hooks, salt, or gunpowder, to the value of about thirty pesos, duly registered before the "Protector de los Indijenes" in Mitu, the value to be repaid in labor, at 40 centavos per day. A credit advance is secured from the Rubber Development Corporation, to be taken in the aforementioned trade goods, fariña, rubber-working equipment such as a milling machine, coagulating pans, acid, or tapping knives, as well as standard provisions such as rice, beans, *panela*, coffee, painkiller ("Good for man or beast," Made in St. Louis), etc. After exhausting their credits and the patience of the entire R.D.C. staff and after innumerable false starts, they are finally hauled away from the Mitu water-front, their thatched *batalones* lashed to the side of our little panting launch with six or eight additional dugout canoes, all loaded to the point of suicide with Indians, fariña, dogs, cats, parrots, monkeys, naked children and caged chickens. The *cauchero* is enthroned in drunken gravity atop a fariña basket, or engaged in hurling his parting imprecations at the gaping group of villagers and unkempt policeman.

Transportation on the Vaupes* and its larger tributary streams is provided by the Company. The long, meandering, monotonous watercourse is flanked by walls of dark, palm-dotted forest, and in the present rainy season the river penetrates far inland below the trees, the scene resembling a Mangrove swamp at high tide. There is remarkably little color, but the varying shades of green are relieved by an occasional tree or vine in flower, graceful white Egrets in small groups, the follow-the-leader diving flight of vivid Toucans, or rowdy gangs of Parakeets shrilling protest at being disturbed. Occasional pairs of brilliant Macaws cross high above the dark river, seemingly engaged in sympathetic conversation.

Frequent rain squalls are met driving down the river, as the launch struggles against the current with its unwieldy load. Head of navigation is finally reached at some *cachoeira* [rapid], and the *batalones* and canoes are released to unload cargo. The Indians drag the craft through the rushing cool water, to the united chorus of "*Ma*", reloading above fast water, and continuing under their own power. The boats are rowed, galley-fashion, by six Indians with round-bladed paddles lashed to long poles. A steersman standing erect on the small platform behind the thatched shelter, with his huge steering oar, resembles some dusky Charon guiding his bark on the stream of time.

* The Rio Vaupes flows through southwestern Colombia and is one of the major tributaries of the Rio Negro, which in turn is a north branch of the Amazon, joining the latter at Mañaos, Brazil.—Ed.

An Indian ceremonial dance mask made of bark cloth.

A *batalón* in the rapids of the Rio Vaupes.

Scenes along the Rio Vaupes, an upper tributary of the Amazon in southwestern Colombia.

Upon arrival at the scene of operations, far in the headwaters of the Querari, Cubiyu, Cananari, or Paranapichuna, axes are distributed, and an acre or more of the great jungle trees are brought crashing down in indiscriminate ruin. A stilted palm-thatched house is built near the water's edge for the Patron, and long thatched *baracones* are erected for the Indians. A large-scale operator may have several side camps, housing four to ten tappers, whose product is brought at intervals to the main camp. The usual method of opening new territory is to run compass lines through unbroken forest, as trials, lateral paths or *estradas* being run to groups of about a hundred trees if the initial survey has been promising. Trees must be selected with great care, since several species of Hevea occur in the region and not all are of commercial quality. These are fairly well known by their Brazilian names. The best grade, produced by *Hevea guianensis*, is known as *Siringa fina* or *Boracha fina fraca*, while the trees producing weak sticky rubber are called *Siringa da Catinga*, *Siringa pegajosa* or *Borracha fraca*, in Spanish and Portugese, and as *Ay Yeca* in Cubeo, or *Wak sog-u-di* in Tucano. Trees in each *estrada* are marked with the initial of the Patron, which gives him the right to exploit them.

A tapper may be assigned two or four *estradas*, to be worked in successive days. The Indian, typically attired in a G-string, with tapping knife, collecting bucket, and muzzle-loading trade gun slung over one shoulder, begins tapping as soon as light permits. His task consists in opening a fresh, narrow cut on the bark of each tree and placing the collecting cup in position so that the rapidly flowing latex will be caught. After reaching his last tree, he usually hunts, fishes, or seats himself tranquilly atop an ant hill, extracting and eating the soldier ants by means of an aggravating bit of palm fiber. After about an hour of such felicitous pastime, he begins his return to camp, on the way collecting the latex from the cups attached to each tree.

Production from *Hevea guianensis* is considerably less than that of *Hevea brasiliensis*, and probably does not average more than 100 cc. [about 3.4 ounces] to a tree per day, although this varies considerably with the weather, and the frequency that the trees are tapped. The tapper usually reaches camp by 3–4 P. M., often with a wild turkey or even a tapir as side-product.

The latex is mixed with one and one half times its volume of clean water, strained carefully to remove dirt and insects, and 2½ liters [about 2.6 quarts] of it measured into each coagulating pan. Dilute acid is carefully added, being thoroughly stirred so that no lumps will form. Under ordinary circumstances coagulation takes place in one to two hours, the

rubber separating in a pale yellow spongy cake which floats on the pan of not-entirely clear water. These cakes are removed as soon as possible without breaking them to pieces, washed in clean water and milled, the laminating machine being opened to nearly the thickness of the cake. Successive passages through the machine are made at finer and finer gradations until a paper-thinness has been attained for the sheets. These are again washed and hung on tightly stretched vines to dry. Usually they are passed, about twenty-four hours later, to a closed shed, where they are again suspended and subjected to intense smoking for about a week. By this time the sheets have acquired a deep, almost wine-red color when held against the light, and a strong permanent smoked smell. They can now be bound with tough vines into bundles weighing about fifty kilos, being then ready for shipment. Under ordinary circumstances, the Patron can expect about 150 kilos [330 pounds] of rubber per tapper, for the season. Traditionally the season is from early September until early February. Then the Indian returns to his *maloca* in time for the great ceremonial dances coincident with the ripening of the fruits of the Papuña palm *(Guilielma (Bactris) Gasipaës)*. If all has gone well, the Patron has made money which will last him about forty-eight hours after he sets foot in Villavicencio. After that he will return to the Vaupes, draw another credit, and begin the process over again.

A QUARTER CENTURY OF TREE SURGERY

AUGUST P. BEILMANN

About twenty-eight years ago, in June 1917, the BULLETIN carried an illustrated article on the art of tree surgery, in which that phase of tree care now known as "cavity work" was described in considerable detail. It would be rather difficult to-day to honor the first man to install a filling in a decayed tree, a number of men having claimed credit or been denounced for originating this work. In all probability some long-forgotten gardener applied a poultice of cow-dung, lime, and wood ashes to a freshly barked tree and discovered that the cambium quickly grew over the injury. The applier of such a poultice knew little about tree surgery as we understand the term to-day. Nevertheless, he was a tree surgeon since he found a method of healing wounds, and the modern operator can do no more.

From the tone of the 1917 article, we gather that the writer was disturbed by the methods of the "tree doctor." He points out that the operations are simple, provided the cause and the nature of decay are thoroughly understood. But he disliked the effort, then being made, which fostered

the impression that a "certain inner communion" is necessary between the tree doctor and his patient. The public acceptance of cavity filling is somewhat lessened to-day, and we can confine ourselves to some observations concerning the effectiveness of fillings which have lasted a quarter of a century. Then too, the problem can now be approached with less heat than was possible some years back. Time, which heals all things, but not necessarily tree wounds, has since shown both the tree owner and the surgeon that a filling is not a cure-all.

There are now two schools of thought: the first insists on filling a cavity; the second insists on leaving a cavity open or unfilled. In part, the difference of opinion is due to the granting of patents covering design, the filling itself, the drainage, or some other development which seems necessary for successful work. In regard to the material used as a filler, it may be said that everything has been used at one time or another. Concrete has probably been the most common, although asphalt, cinders, bricks, masonry, rubber, wax, and sawdust have been acceptable. In every case it was hoped to find the material which was weather-proof, rot-proof, very durable and at the same time flexible. Perhaps modern plastics will some day solve the problem. But twenty-five years ago concrete had the durability, and the flexibility was added by dividing the filling into smaller units.

In 1917 it was quite common to nail a copper or zinc sheet over the opening, the idea being to furnish a base on which the new bark might grow. After all, the most solid and durable filling accomplishes no more. Such "tinned" cavities are no longer installed simply because it is impossible to prevent re-infection, assuming that the original disease was entirely removed. Present-day solid materials—no matter what they are—at least exclude some air and reduce the chance for re-infection if they fill the cavity completely.

We recently had the opportunity to examine the fillings in some of the trees which were described in the 1917 BULLETIN. One elderly patient which survived the operation was a Soft Maple *(Acer saccharinum)*. It was removed in 1943 for safety reasons, and the condition of the trunk is shown in fig. 1. A ring count at the time of its removal showed the planting date to be 1861. In 82 years it had reached a height of 62 feet and a trunk diameter of 37 inches. For some reason the lower part of a long trunk cavity was filled with concrete while the upper part was covered with tin. Squirrels had succeeded in gaining an entrance to the tinned portion and further decay had loosened the concrete part. The tree had attempted to heal over the cavity as shown by a generous ring of callus

Fig. 1. Removal of Soft Maple which underwent the surgeon's knife in 1917.

growth. We cannot say at this time that cavity work was successful in this tree; nor can we say that it failed. It is not possible to tell whether the life span was shortened or lengthened, or if the tree continued to grow in spite of the work done. At any rate, the tree was much less unsightly than it would have been without the filling.

Another patient treated in 1917 appears to have fared better. This was a Golden-Rain tree *(Koelreuteria paniculata)* which had been very poorly filled some years earlier. The broken filling was removed in 1917 and the most modern material installed, in this case being an asphalt surface with a backing of cinders and sawdust. There is no question but that this treatment served the purpose. The injury was far less conspicuous after the filling than before. With this tree, then, the cavity work was justified, and it was successful.

Fig. 2. Golden-Rain tree with 1917 cavity nearly healed over.

A third patient described in the BULLETIN was a Yellow-Wood *(Cladrastis lutea)*. To-day very little of the tree remains; in fact, only that part of the tree which received no surgery is alive. The upper part of the trunk and some branches were decayed, and those parts which had been excavated and tinned have disappeared, only a very short main trunk and one large branch being still in position. A fourth tree which received some attention at the same time had a cavity of considerable size on the main trunk. A concrete filling, separated into four parts for flexibility, had been installed. It is quite possible that this tree, which was mature, did not completely recover after the operation; at least it was removed many years ago. Another concrete filling had been installed in a hybrid Buckeye *(Aesculus hybrida)*. The filling remains but decay has continued, so the work appears to have failed. We may say, then, that two operations were successful, since the

patients recovered and the wounds were partly healed. Two other trees failed to recover, and although some scar tissue formed the trees have since been removed.

Some explanation of the functions of the various parts of the tree may be helpful in understanding the healing of tree wounds. The trunk of a tree serves to hold the leaves in the light, and at the same time it acts as a conveying and storage organ. Some food and some water are available here at all times. The roots are primarily anchors and absorbing units; they assemble the raw salts and the moisture. The leaves may be likened to stomachs; they synthesize sugar from water and carbon dioxide. The sugar, which is needed by all living cells, is transported downward from the leaves to the roots, and on the way it becomes available to all growing tissues. Only the outside portion of the trunk—a mucilaginous layer of cells just under the bark called the cambium—is alive. It is from this sheath of living cells that all healing of wounds takes place and no callus will grow over a filling or a pruning cut if these cells are injured. It will be seen, then, that the removal of portions of a tree trunk may have no effect on the tree itself. If decay enters the tree, no harm follows unless the trunk is so weakened that it breaks in storms. Successful cavity filling is based on the assumption that all dead wood can be removed and some material put in its place. Whatever is finally used for the filling, it should be weather-proof and flexible, or have this feature incorporated in the design. It probably doesn't matter what is used for filling, provided it stays in place and is not injurious to the callus growth.

All decay is the result of wood-destroying fungi. The microscopic spores enter a tree through some injury to the bark. After they have entered and destroyed some of the trunk there is no way to stimulate the bark to cover such an injury except by removing all diseased wood and filling the cavity. The filling itself adds nothing to the strength of the trunk. If decay has progressed far enough, then special steel reinforcements are needed to replace the lost wood.

The care used in the removal of all the diseased wood during the actual excavating of the cavity is usually the key to success or failure. It is of course very difficult, if not impossible, to remove all trace of infection from the trunk of a tree. There is no way, short of an elaborate laboratory analysis, to determine how far some wood-destroying fungi have penetrated apparently sound wood. Usually some strong fungicide is applied to the cavity before the filling is begun. Even if all disease is killed at that time, there is no way to guard against re-infection. No filling, no matter what its good qualities, becomes so much a part of the tree that diseased spores

cannot enter alongside of it. On the other hand, it is probably true that any kind of filling will tend to check wood rot. The exponents of an open cavity, however, appear to be equally successful although they place much more dependence upon sanitation.

Not every tree is attacked by the same kind of disease. Some are notably susceptible to heart rots, which destroy the trunk in just a few years. Others are seldom attacked by these, but they may be injured by fungi which destroy the wood much more slowly. It is always a mistake to attempt cavity work on a species known to be attacked by a serious heart rot. Usually the harder the wood and the slower a tree grows, the less susceptible it is to decay and the more likely it is to heal over a filling. The Poplars, Birch, Willows, Sycamore, and some Elms make very poor patients. The Soft Maple, if young and vigorous, may respond to treatment. The Oaks, the American Elm, Sweet Gum, and Linden are usually suitable patients.

We may summarize cavity filling somewhat as follows: If a tree is young and vigorous and occupies an important position in the landscape, treatment may be justified. However, the life expectancy of the tree must be given consideration. If it is growing in a spot hemmed in by buildings and drives so that parts of the root system have been, or will be destroyed, or if it is so placed that no feeding is possible, the tree is a very poor risk. Should the tree be one, such as the Elm, which in some parts of the country may be attacked by one of several serious diseases, it is also a poor risk. Successful cavity work, then, depends on the condition of the patient. The best patient is a tree in the prime of life growing under relatively natural conditions, and a species not subject to the epidemic disease of the moment. It is necessary, of course, that the tree surgeon be thoroughly familiar with his work, but, on the other hand, no matter how experienced he may be, he can not transform a rotting Oak into a fine vigorous tree. He can do little more than arrest decay, replace the lost wood with steel bracing, control the insect pests, and keep his patient comfortably fed and watered. While it is theoretically possible to eradicate decay, in actual practice this does not happen. The very best the tree surgeon can hope to do is to check the spread of a disease and, by feeding and watering, to overcome the neglect which was the prime cause of the trouble.

THE PINE-FERN—A LIVING LINK WITH THE PAST

HENRY N. ANDREWS

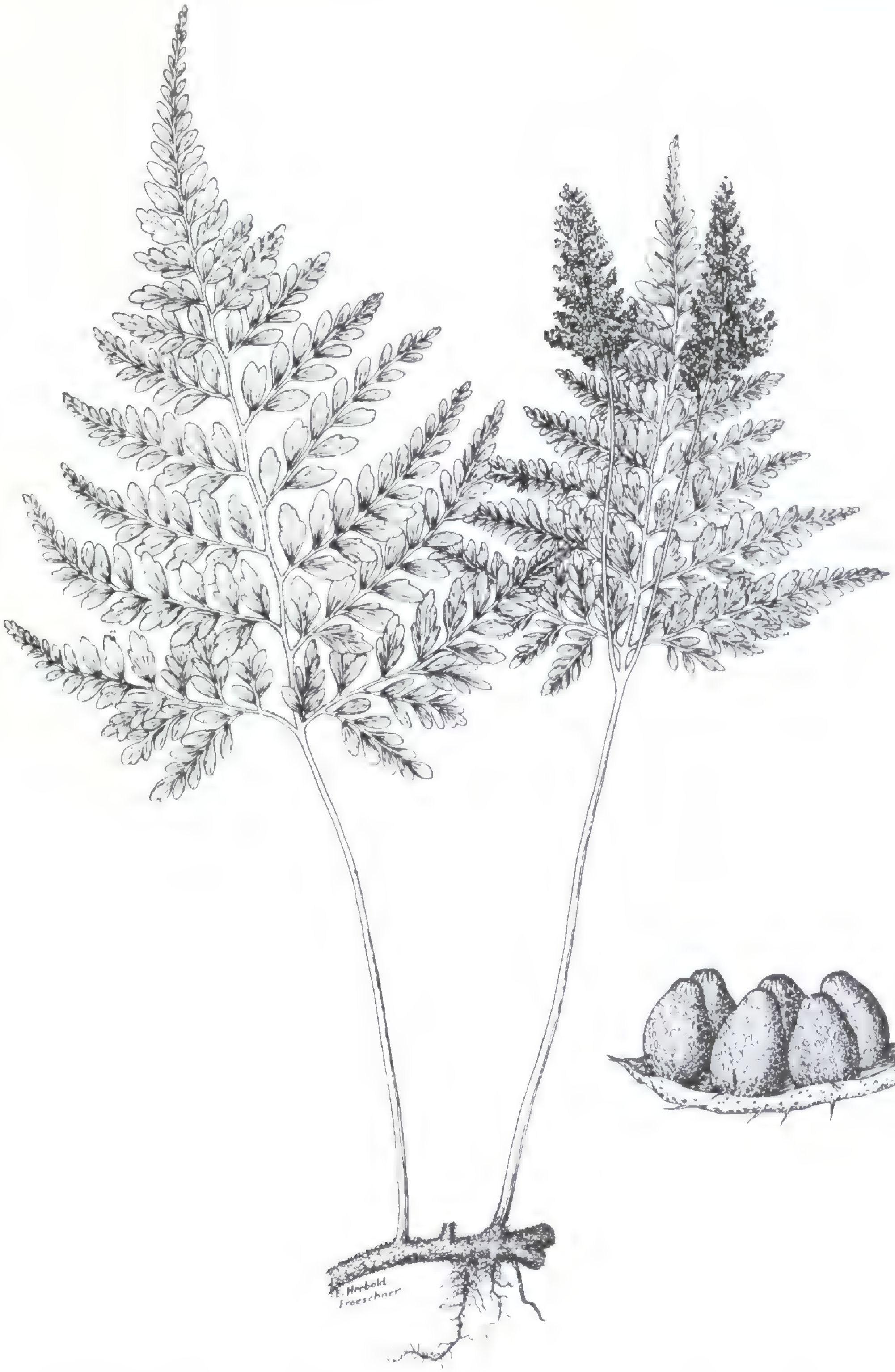
There are many plants living on the earth to-day whose direct ancestors have been traced back into the geologic past for tens, even scores, of millions of years. The antiquity of their genealogies so far surpasses our own that we find it difficult to think in terms of so many centuries of centuries. Botanists refer to these ancients of the plant world as living fossils. The stories of some, such as the Ginkgo, Redwood, and Pine, have been told many times. Yet every year fossil hunters dig into previously unknown deposits, or they grub around in the old ones, and new links are added to our chain of knowledge of the plant kingdom's past history. There are other plants whose lineage is much more ancient than that of any of the trees mentioned above, less conspicuous in many cases, yet equally important as reminders of the changing landscapes that have come and gone with past geologic periods.

The story of the Pine-fern has been selected, not because it is an especially well-known fern, but rather because it is a patriarch among the ancients, literally older than the hills, and the solution of its ancestry reveals a few of the ways that fossil botanists go about their work.

The modern Pine-fern *(Anemia adiantifolia)* is at home in the Pine woods of Florida and the Keys, favoring the barren walls of limestone sinkholes. Although its close relatives, the Climbing Fern (Lygodium) and the Curly-grass Fern (Schizaea) are found, albeit rarely, as far north as New Jersey and Pennsylvania, Anemia remains partial to the soft breezes of the Caribbean. Long ago it relinquished its last claims to the vast areas of temperate North America over which it roamed, but many fragmentary records were left here and there in the rocks—fossil leaves and stems that hold the secrets of forgotten ages.

To-day the plants are small, with leaves not often exceeding a height of two feet and rising from slender stems that creep along just beneath the surface of the ground. The fronds are all pretty much alike, but sometimes the two lower branches (primary pinnae), instead of being typically foliar, bear fuzzy clusters of partially coiled leaflets on the under side of which are two rows of spore sacs nearly hidden by a blanket of rust-colored hairs.

In contrast to the subtropical seasons of southern Florida and the Keys, let us turn to the arid sage-brush hills of southwestern Wyoming where the days are pleasant enough in midsummer but where the climate otherwise offers very little encouragement to plant life. In rocks of Cretaceous age that tilt upward toward the sky to form a ridge extending north and south for many miles there are found beautifully preserved fossil fern leaves be-



A modern Pine-fern *(Anemia adiantifolia)* from Florida—the two lower branches of the frond at the right bear rusty-brown clusters of spore sacs. At the lower right a single leaflet is shown with six spore sacs.

longing to plants that grew there more than one hundred million years ago, in an age that knew somewhat more favorable environs. Instead of the desert, the gray sage, perhaps an antelope, and sharp mountains in the distance to break the monotony, we may picture in that time wooded hills and streams, a lake in the background, and a warm sun all the year. This does not necessarily imply the "lush vegetation" of modern tropical rain forests, but the fossils do suggest a closer approximation to such a landscape than is found there now.

Fig. 1. Petrified fern stems *(Tempskya)* on the former ranch of C. H. Thomas, near Wayan, Idaho.

In 1843, when Captain John C. Fremont was exploring western Wyoming in search of a better route to Oregon, he gathered specimens of fossil Pine-ferns a few miles south of the present town of Kemmerer. Later, coal-mining camps mushroomed into life along one side of the ridge, and it is in the shales that lie above the coal seams that the fossil ferns are found. In more recent years additional specimens have been gathered which reveal not only the sterile foliage but the spore sacs and their contained spores in a nearly perfect state of preservation.

Fig. 2. Gleichenites, a member of the tropical Net-fern family, also found in the Cretaceous rocks of Wyoming.

In pl. 16, fig. 4, is shown, enlarged somewhat, one of the specialized spore-bearing lower branches of a fertile frond. These appear as flattened, black compressions (fossils of this sort are also referred to as mummified remains) on the hard gray shale, yet they may be removed from the rock by coating

Figs. 1, 2. Parts of the foliage of the fossil Pine-fern from Wyoming. 3. A lower branch of a frond bearing tightly coiled leaflets on the under side of which the spore sacs are found. 4. A portion of fig. 3 enlarged. 5, 6. Fossil spores, highly enlarged. 7. Spore of the living Florida Pine-fern.

the fossil with celloidin and then dissolving the mineral matter away with hydrofluoric acid. Next, small fragments of the specimen that adheres to the celloidin film are selected, and while watching them through a low-power microscope, they are immersed in a strong oxidizing chemical. Within a few seconds the tiny bean-like bodies will unfold into five or six finger-like lobes, on the under side of which the spore sacs are borne in two rows. It is evident in some cases that the plants were deposited just before maturity, for when the spore sacs are broken their contents tumble out, about 120 spores from each sac, just as they normally did in life so many millions of years ago.

Weathering out of rocks of a very similar age only a few miles away, as well as in corresponding Cretaceous deposits of Idaho, Montana, and Oregon, petrified fern stems are found scattered over the desert floor. Although conclusive proof is still lacking, there is reason to believe that these are the stems, known under the name of Tempskya, that bore the Anemia foliage. If so they were much more impressive plants than their modern Florida counterparts, for the fossil stems attain a diameter of fourteen inches and trunk fragments three feet long have been found. The foliage was borne in a crown at the apex, presenting an appearance that must have been similar to the living cycads and tree ferns.

The internal structure of these Tempskyas is beautifully preserved and quite different from that of almost any other plant. If one examines a polished or weather-beaten cross-section it appears to consist of a score or more (depending on the size of the trunk) of small circles about one quarter of an inch in diameter. Commonly referred to as "eyes" by mineral collectors, they are actually woody cylinders and are enclosed in a dense tangle of minute roots. Tempskya was both an abundant and widely distributed plant in upper Cretaceous times, the petrified trunks having been found in various parts of Europe as well as in eastern and western United States. On one occasion we chanced upon some particularly fine specimens serving as foundation stone under a ranch house in Idaho—a rather difficult spot on which to collect them without unduly disturbing the owner!

In all probability these plants with their short massive trunks grew along the shores of lakes or streams where spring floods readily wrenched them loose, whence they were carried out into the lake or swamp, deposited, and soon covered with the silts brought in by streams. Those ancient bodies of water have long since dried up, their sediments consolidated into rock, and the rocks elevated to form the low jagged hills that rise above the plain today.

If a few words of pure speculation may be inserted here, it seems very possible, in view of the evident abundance of these plants, that the foliage

served as a source of food for the great herbivorous dinosaurs of the period. Although those huge beasts had reached the zenith of their racial development a few million years earlier, many still remained, fighting a losing battle against changing climates and the rising mammals. We know very little of their dietary habits, but living as they did in the vicinity of swamps, equally ideal places for ferns, there is little doubt that these plants were attractive luncheon items for the great reptiles.

Going back still farther into the past, we again pick up the trail of Anemia predecessors in the Coal Age (Upper Carboniferous) rocks of Illinois and England. Conservative estimates place this period at least 250 million years back in the past, and, as might be expected, Anemia's ancestors had changed considerably in the eons of time that intervened between this and the Cretaceous. At first glance the identity of these Carboniferous fossils, bearing the scientific name Senftenbergia, would hardly be recognized. The foliage is quite different from that of the modern Pine-fern of Florida, but the structure of the spore sacs is close enough to leave no doubt as to their family relationships, and it is the reproductive structures that botanists consider most trustworthy in basing their classifications.

The spore sacs of these Carboniferous relatives bear a distinct double ring of thick-walled cells at their apex (instead of a single row as in the Florida Anemia) and when the sporangia were ripe they contracted, splitting lengthwise, thus liberating the spores. In rocks of even greater age (Lower Carboniferous) other species of Senftenbergia have been found in which the cells of this opening mechanism were less regular in their arrangement, extending down along one side of the spore sac; seemingly they had not "settled down" to the regular organization that prevailed in later ages.

What happened prior to this early Carboniferous age is unknown, and indeed there are many gaps since then that remain to be filled. In time some of these will be, but of course many of the plants that lived in past ages were not preserved as fossils and their story has been lost forever.

A question that is bound to follow is: What is going on in the Pine-fern family now? What will botanists find in another one hundred million years? A great deal certainly depends on climatic changes. It seems doubtful that the Pine-fern or its future descendants will ever invade the more northerly latitudes unless warmer temperatures again become prevalent. But what is perhaps even more important is the sociological problem that they encounter in competing with the now-dominant flowering plants. The latter came in with a rush in Cretaceous times and were at least partially responsible for crowding the Anemias and their relatives out of the more extensive areas that they occupied at that time.

NOTES

The flower exhibit in the Floral Display House during April will include Azaleas, Calceolarias, Canterbury Bells, Cinerarias, Foxgloves, Marguerites, Schizanthus, and Snapdragons.

The annual flower sermon, provided for in Henry Shaw's will, was preached at Christ Church Cathedral, April 15, by Dr. Douglas V. Steere, Professor at Haverford College, Haverford, Pa.

Mr. Rodney Wilcox Jones, President of the American Orchid Society, ordered 1500 copies of the November 1944 and February 1945 issues of the MISSOURI BOTANICAL GARDEN BULLETIN for distribution to members of the American Orchid Society.

Recent letters from Sgt. Fred G. Meyer and Sgt. Gerald B. Ownbey, both former graduate students at the Garden and stationed at Army hospitals in different parts of England, tell how, after much arranging and planning, they were able to meet in London for a visit to the Royal Botanical Gardens at Kew.

A sunrise service was held in the Trail House at the Arboretum, Gray Summit, on Easter Sunday, April 1. The services were inter-community, inter-denominational, and inter-racial, the churches of Pacific, Gray Summit, Catawissa, Labadie, Oakfield, St. Albans, and Villa Ridge co-operating. About 400 people attended.

The yellow Narcissus "February Gold" continues to prove itself the best early variety for St. Louis gardens. Plantings made four years ago in an unfavorable site have flowered every year since and made a fine showing this year. Though they bloom in March rather than in February they are quite as early as the little old-fashioned yellow Daffodils and are a much better garden plant in most ways.

Recent visitors to the Garden include: Sgt. Louis J. Brenner, of the U. S. Army, formerly a graduate student at the Garden; Dr. William L. Brown, of the Pioneer Hi-Bred Corn Co., Johnston, Iowa; Mr. James G. Esson, Editor of *Gardeners' Chronicle*, New York City; Mr. T. H. Everett, Horticulturist, New York Botanical Garden, Bronx Park, N. Y.; Mr. J. W. Johnston, Horticultural Editor, *New York Herald-Tribune*; Mrs. Paul H.

Allen, of Bogotá, Colombia, S. A., wife of Paul H. Allen, the Garden's former Representative in the Tropics and now Field Technician, Rubber Development Corporation, Colombia; Dr. Norbert Wiener, Professor of Mathematics, Massachusetts Institute of Technology, Boston; Mr. C. M. Kilian, Orchid Grower, Birmingham, Ala.

Many shrubs will be blooming outside at the Garden during the month of April, the most conspicuous being the deciduous Azaleas. The finest of all the pink Azaleas, *Rhododendron Schlippenbachii*, blossomed well this year. While the plants are still too small to give a mass effect, it is heartening to know that they have reached flowering size here and that a finer display may be anticipated in future years. In the Grove, in late April, will be a mass of blue, pink, and white Wood Hyacinths, varieties of *Scilla nutans* and S. *campanulata*. These bulbs are listed in some catalogues and botanical works as English and Spanish Bluebells, *Scilla nonscripta* and S. *hispanica*. In this confusion of common and botanical names it would seem more appropriate to call them "Wood Hyacinths." There would then be no excuse for calling a large mass of white Wood Hyacinths English or Spanish "Bluebells." Both at the Arboretum and in the City this has been an unusually good year for the White-flowered Redbud. At both places the two color varieties have been planted intermingled and the branches of white and rose-pink create a very fine landscape effect.

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MISSOURI BOTANICAL GARDEN BULLETIN

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THE NIGHT-BLOOMING CEREUS AND ITS ALLIES

LADISLAUS CUTAK

Night-blooming Cereus! How often have you heard this expression and how often has it been misapplied! Many people do not know that there are a great number of nocturnal cacti, and if they possess such a plant they are under the impression that theirs is the Night-blooming Cereus. Often a plant is called "Night-blooming Cereus" that is wholly unrelated to it, as, for instance, the well-known Broad-leaf Cactus, Epiphyllum. We must remember that the Cerei possess certain peculiarities which distinguish them from other cacti. In other words, every Cereus is a Cactus but not every Cactus is a Cereus. Perhaps this sounds confusing, but let's see whether we can explain it more fully.

In the great Cactus family there are over 50 genera belonging to the subtribes Cereanae and Hylocereanae, and all these have been included under the genus Cereus at one time or other since the binomial system was established by Linnaeus in the eighteenth century. Many members of these two subtribes are day-blooming, but there is also a big group whose flowers do not open until dusk. The following is a list, alphabetically arranged, of the genera of nocturnal cacti. The names represent those accepted by most modern cactologists although slight differences of opinion do exist regarding a few of them, as is to be expected.

Acanthocereus	Eriocereus	Mediocactus	Strophocactus
Arthrocereus	Eulychnia	Monvillea	Trichocereus
Binghamia	Facheiroa	Neoevansia	Weberocereus
Browningia	Harrisia	Nyctocereus	Werckleocereus
Carnegiea	Hylocereus	Peniocereus	Wilmattea
Cephalocereus	Lemaireocereus	Pilocereus	Zehntnerella
Cereus	Leocereus ?	Selenicereus	
Dendrocereus	Lophocereus	Stetsonia	

Any of the above could be called "Night-blooming Cereus," but to be technically correct the name is applicable only to the genus Cereus as it is understood to-day. However, the term is most frequently and popularly

applied to certain species in the genera Hylocereus and Selenicereus, vine-like cacti producing the largest blooms in the Cactus family, and to the odd turnip-rooted Peniocereus. In the opinion of the writer, it would be prudent to confine this name to Hylocerei and Selenicerei, and the great majority of cactus-minded folks exercise this same thought.

Nearly every lover of house plants possesses the gorgeous night-blooming cactus known botanically as *Epiphyllum oxypetalum* (or *Phyllocactus latifrons* to the old collectors), which is almost always mistaken for a night-blooming Cereus. Rightfully it belongs to a separate subtribe, the Epiphyllanae, whose members usually grow on trees and have mostly flat joints. Outstanding in this exotic group are the Epiphyllums, Schlumbergeras and Zygocacti. The Epiphyllums are tall, luxuriant, tropical plants with broad long leaves (really leaf-like stems) and magnificent diurnal or nocturnal flowers. The Schlumbergeras are similar to the Zygocacti in habit, but differ in flower and fruit characters. Schlumbergera is frequently called the Easter Cactus because it blooms in April. The Zygocacti are well-known house plants with many horticultural varieties to which the popular names Thanksgiving Cactus and Christmas Cactus are attached, as their flowering periods often coincide with those dates.

HISTORICAL SKETCH

The name Cereus is from the Greek, signifying a torch and refers to the candelabrum-like branching of the first species known. Now none of the flat-jointed Epiphyllanae are considered as related to the Cereanae, nor do they even remotely bear a likeness to any of the Cerei or Torch Cacti, so the name "Night-blooming Cereus" should not be applied to any of the Epiphyllums.

Cereus is perhaps the oldest name given to any cactus, for it was mentioned in literature as far back as the sixteenth century. It is not definitely known who first used the name. Philip Miller, the author of the famous "Gardener's Dictionary" published in the early eighteenth century, credits the genus to P. Hermann in 1698, but the name itself was in use for more than seventy years prior to that date.

The discovery of the Cacti must have left an indelible mark in the minds of the first American explorers, who referred to them as torches or candelabras and thereby aided in giving the descriptive name, Cereus, to these curious plants. Miller, however, states that the plants were not called Cereus from their resemblance to a torch alone, but also from the fact that servants burned them as torches or tapers and carried them at nights before their masters. To make the torches, the spiny specimens were cut down, dried on the ground, and dipped in oil.

The earliest illustration of a Cereus is believed to be in Oviedo's "La Historia General de las Indias," published in 1535. This work of Oviedo's, whose full name was Gonzalo Fernandez de Oviedo y Valdes, is the first natural history of America, one of the rarest and most important books on the New World. Oviedo gives a general view of Spain's new American empire and the policy which should be adopted towards its people by the monarchy. The book was partially suppressed in Spain because this Spanish historian dared to tell how the Indians were abused, and this apparently accounts for the book's signal rarity. The illustration is a curious and crude woodcut which does not lend itself to critical discussion but, because of its historical value, is reproduced here (fig. 1).

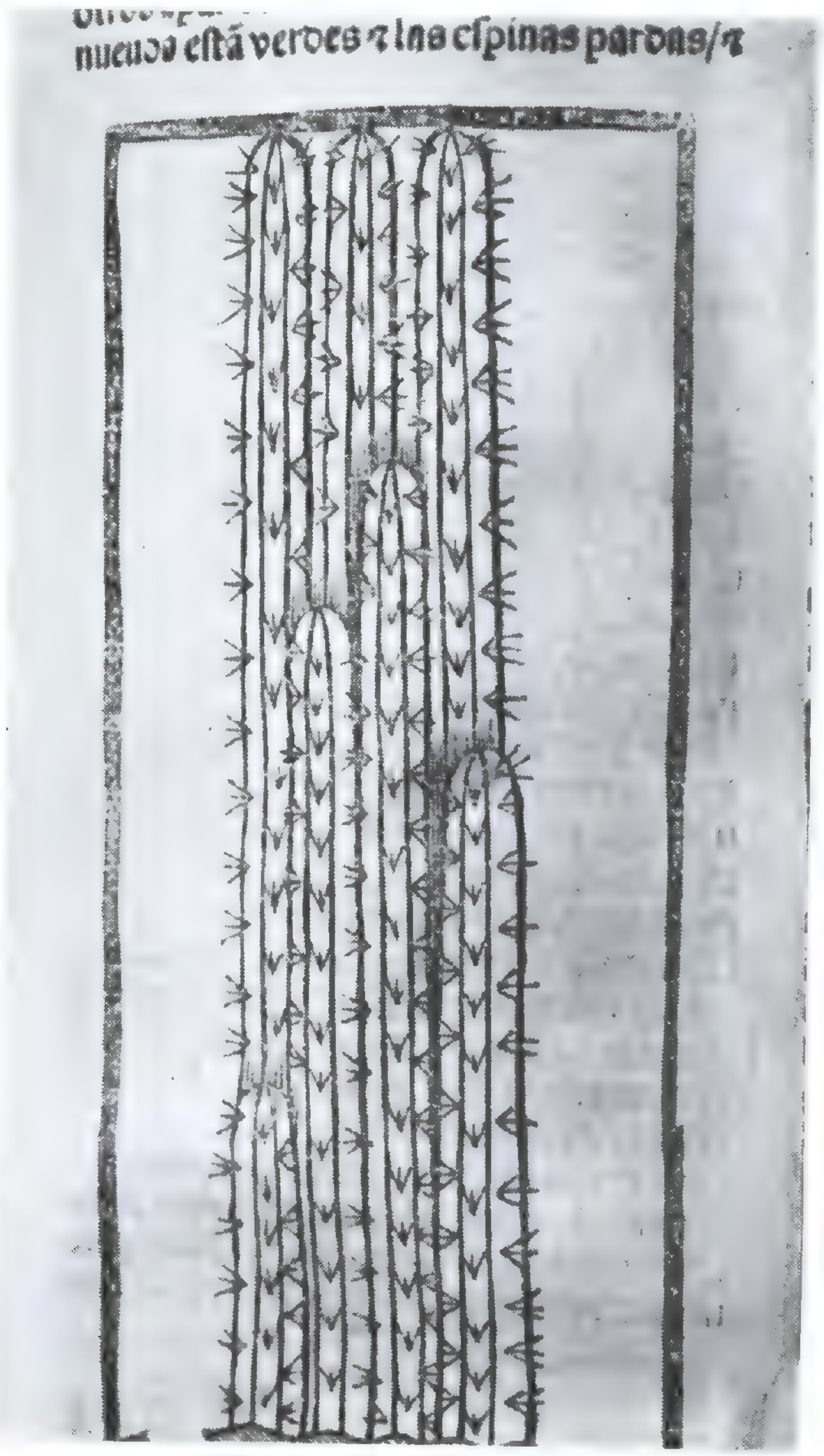

Fig. 1. Oldest illustration of a Cereus on record, from Oviedo's "La Historia General de las Indias," 1535.

The first colored figure of a Cereus presumably appeared in a modest little Aztec herbal in 1552, which happens to be America's earliest treatise on Mexican medicinal plants and native remedies. The exciting and unique manuscript was written in his native tongue by an Aztec physician, Martinus de la Cruz, and was translated into Latin by a compatriot, Juannes Badianus. For more than 300 years it had lain hidden on the shelves of the Vatican Library until Dr. Charles U. Clark brought it to light in 1929. The unidentified Cereus is there called *teonochtli*, which means "Divine Cactus," and the paragraph beneath the illustration is devoted to the toothache and

Fig. 2. Oldest illustration of *Cereus peruvianus*, from L'Obel's "Stirpium Adversaria Nova" (p. 453'. 1576.

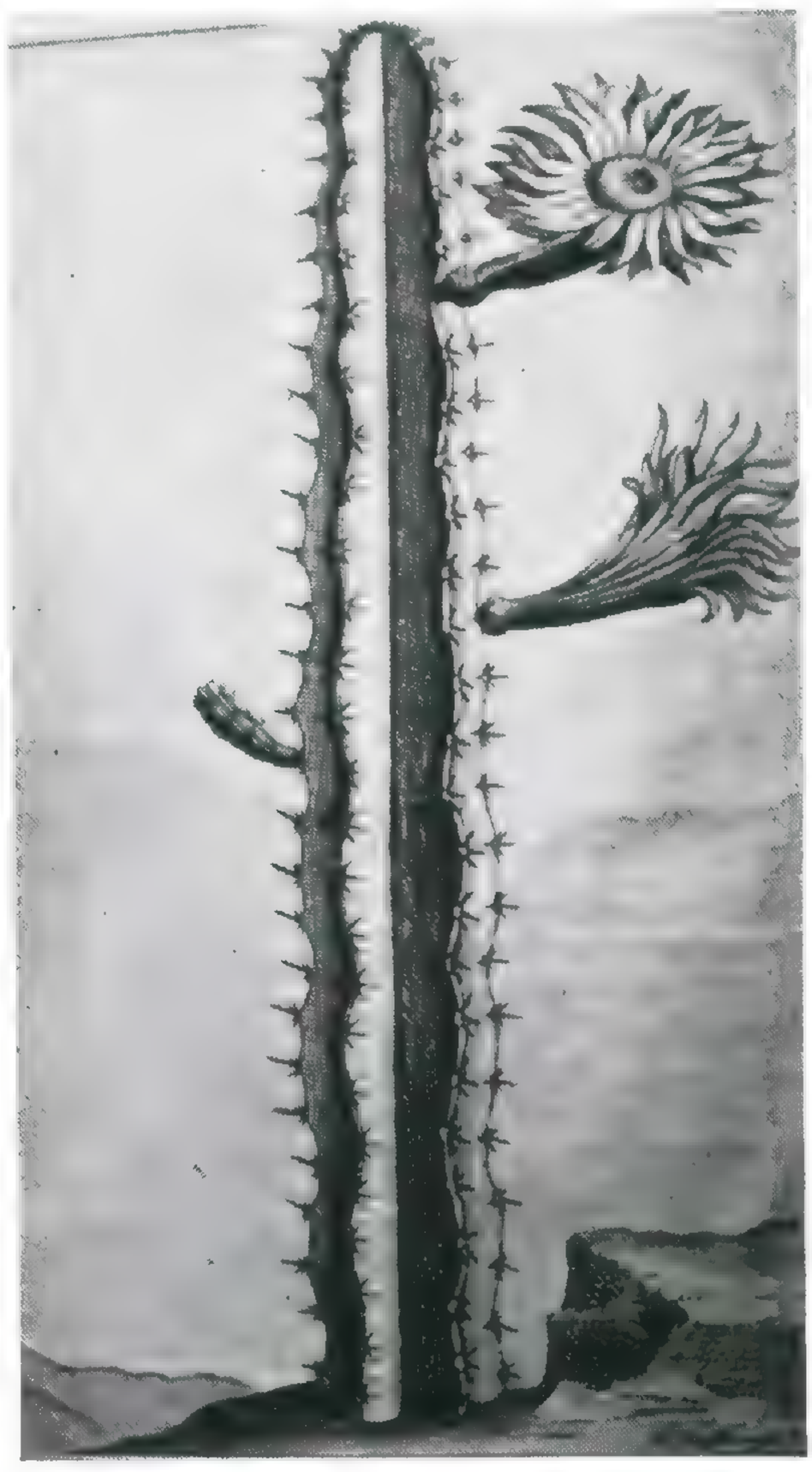

Fig. 3. One of the earliest figures of a flowering Cereus *(C. peruvianus)* from Bradley's "History of Succulent Plants," 1716.

how it can be cured with the root of this plant. Like Oviedo's earlier woodcut, the plant in the Badianus illustration defies critical naming beyond the fact that it appears to be a Cereus of some sort, perhaps related to Lemaireocereus.

Another interesting early illustration of a night-blooming Cereus (with-

out the flowers of course) was published in 1576 by Matthias l'Obel (Lobelius) in his "Stirpium Adversaria Nova." The identical figure was reproduced fifteen years later in his "Icones Stirpium" and is now identified as *Cereus peruvianus*. The famous herbalist, Jakob Theodor von Bergzabern, better known as Tabernaemontanus, made use of Lobel's figure in his elaborate herb book, "Neuw Kreuterbuch," on which he worked for 36 years before it was published in 1588-91. However, he apparently made a new woodcut as the figure is slightly altered and reversed, though hardly noticeable except on close scrutiny. Many of the old herbals show that illustrations of Dodoens, Bock, Clusius, and Lobel were frequently made use of. Tabernaemontanus, for one, borrowed his cuts as did many others.

In 1716 Richard Bradley published one of the first excellent figures of a nocturnal Cereus in flower in his "History of Succulent Plants" (fig. 3). In a note to the reader he stated "whatsoever figures I shall publish, will be (as near as I can make them) perfect copies of those plants they are to represent and shall be engraved by the best hands." The figure, executed by H. Hulsbergh, who made many other plates for Bradley, shows expert workmanship and depicts a plant then known as *Cereus erectus maximus americanus*, etc., or as we know it to-day, *Cereus peruvianus*.

Worthy of mention here are two beautiful colored plates of *Selenicereus grandiflorus* (plates 31 and 32) executed by John Jacob Haid for Ehret's "Plantae Selectae," edited by bibliographer Christopher Trew in 1754. They show, in practically exact color and natural size, figures of stem, flower and fruit with their minute characteristics. There may be earlier color illustrations of a blooming nocturnal Cereus of which this writer is not aware, but it is doubtful if they can approach the beauty and exactness of Trew's publication. In 1760 Philip Miller published in his famous "Icones" another excellent color plate of S. *grandiflorus* (plate 90) under the descriptive name *Cereus scandens minor polygonus articulatus*, which he translates as "the lesser creeping jointed Torch-thistle with many angles," but it does not compare with the one in Trew's volume. Although the "Icones" was printed in 1760, the plates were executed earlier, that of the particular Cereus on May 25, 1756, along with five others.

PENIOCEREUS OR THREAD CEREUS

In the United States there is only one native nocturnal cactus to which the name "Night-blooming Cereus" is often applied. This is the curious *Peniocereus Greggii*, native to Arizona, New Mexico, and Texas. Its stems are few and the most unpromising things you ever saw—mere "dead-looking" branches of dull gray-green protruding inconspicuously or interlaced among desert bushes. It is a difficult cactus to find when not in

flower, for its top growth hides in the shelter of creosote bushes (*Larrea tridentata*) or climbs into the sturdy branches of mesquite (*Prosopis juliflora*) seeking protection from devastating winds and scorching sun. These stems are leafless, in color lifeless, and possess no particular beauty of form —just mere slender 4- or 5-angled sticks with tiny blackish spines in their areoles (small areas where the spines or flowers, or both, are borne). The most surprising thing about the plant is the root, which is a fleshy tuber resembling an overgrown turnip or carrot and weighing anywhere from 5 to 30 pounds—even 60 to 125 pounds have been reported. These massive tubers are underground water reservoirs, but the contents are so bitter that the plant is practically immune to attack by desert rodents.

In the picturesque deserts of the Big Bend region of western Texas the writer had the opportunity to examine many Peniocerei whose stems were tunnelled by an unidentified borer about one-half inch long. However, the slim branches did not afford the larvae much in the way of food. Most of the plants seen on the 1938 trip had already set their fruit—bright red, egg-shaped "apples"—much relished by birds, rodents, and other native fauna.

One would hardly expect much beauty from the straggly growths of a Peniocereus but it produces one of the fairest flowers of the desert. The tiny hairy buds begin to swell and open in June. The large petals unfold shortly after dark and spread out into lovely waxen blossoms as big as a saucer. They wither on the morning of the following day. While they are in full bloom they fill the air with a most exquisite perfume which can be detected for some distance and betrays the location of this elusive plant. The flowers, measuring 4 or 5 inches across and from 7 to 9 inches long, are white with a lavender tint and tinged with maroon toward the center. The Night-Blooming Cereus of our southwestern deserts was first described about a century ago. It is sometimes called "Deerhorn Cactus," but the more descriptive name "Sweet-potato Cactus" is fast supplanting it.

HYLOCEREUS OR FOREST CEREUS

The genus Hylocereus is composed of about eighteen species of climbing cacti, the stems adhering to walls, tree-trunks, or other supports by means of numerous aerial roots. The best known of all night-blooming Cerei is the widely cultivated *Hylocereus undatus*. Its stems are elongated, 3-angled or winged, with horny margins, and almost inconspicuous spines in their areoles. Our plants in the Cactus House creep upon a trellis 25 feet high and then hang suspended from one of the angle irons at the roof. The blooming season begins in early July and continues until the end of October. During the summer the whole trellis is aglow with blossoms, sometimes as

Fig. 4. *Hylocereus undatus.*

Fig. 5. *Hylocereus costaricensis.*

many as 50 appearing in a single night. In the fall, should the mornings be cool and cloudy, they remain open up to forenoon.

The flowers of *Hylocereus undatus* (fig. 4) are quite succulent, especially the foliaceous scales that cover the ovary and flower tube. They attain a length of 11 to 12 inches and are shaped much like a funnel. The dazzling white petals are 4½ inches long, oblanceolate with apiculate tips, and curve just enough to form a cup of pure white which reposes in a saucer of yellowish green sepals. The cup is filled with a great number of thread-like, cream-colored stamens arranged in two series, each thread topped by a yellowish anther. By actual count it was found that as many as 830 stamens are produced in a single flower. A rather stout, thick, cream-colored, cylindric style protrudes from this mass of stamens and bears at its apical portion a radiating crown of yellowish stigma lobes, up to 27 in number. The foliaceous scales on the ovary and floral tube are bright green, often with reddish tips and margins. The mature fruit is of a dull red color, nearly smooth, and contains white edible pulp sprinkled with blackish seed.

Probably the most famous hedge of this night-blooming Cereus covers a stone wall on the campus of Punahou College in Honolulu. Here it stands 6 or 7 feet high, and it is said that as many as 5000 super-fragrant, creamy white flowers open on a single night. This massive hedge was started about a century ago by Mrs. Hiram Bingham, the wife of a missionary in Honolulu, and now it has grown to one-half mile in length.

Another Hylocereus which grows well and flowers frequently in cultivation is *H. costaricensis*, native of Costa Rica as the specific name indicates. It is a vigorous vine, perhaps the stoutest of the genus, and for this reason produces good stock for grafting purposes. The stems are more turgid than those of the preceding species and of a bluish white color. The young flower buds are globular, tinged a dull crimson or purple, and quite conspicuous along the more-or-less wavy margins of the joints. When fully opened individual blossoms measure 9 inches across. Scales on the ovary are closely set, greenish with deep purple margins and tips. Toward the top of the floral tube they become more elongated and deeper green with more reddish purple tips and margins until they merge with the narrow yellowish green sepals. The petals are three times as broad as the sepals and pure white. The stamens are numerous, about 3½ inches long, with creamish white filaments and yellowish anthers. The style is a thickened, ivory-white organ, nearly 9½ inches long, with 24 to 27 light creamish yellow stigma lobes. In our collection, *H. costaricensis* is a very worthwhile plant. The flowers bloom throughout the summer and fall, and since they stay open long after dawn they can be photographed in all their beauty

in daylight. On September 11, 1940, two flowers remained fully open until 5 o'clock in the evening. Curiously, although that morning was quite cool, it had warmed up considerably in the afternoon. This was one time when a night-bloomer became a lovely day-bloomer, to the enjoyment of visitors at the Garden.

In the estimation of the writer, the most beautiful species of Hylocereus is *H. Lemairei*, which bloomed for the first time at the Garden last year. The flowers are somewhat small, averaging only 10 inches long, but possess delicate tints. Scales on the ovary and lower part of the floral tube are ovate to ovate-elongate, light green (Biscay Green of Ridgway*), with margins and tips Burnt Lake to Blackish Red-purple. Farther up the tube they become much elongated and greenish yellow with the usual red-purple margins. The outermost sepals or uppermost throat scales are a Javel Green

Fig. 6. *Hylocereus Lemairei.*

on the outside, Wax Yellow on the inside with a purplish tip. The sepals proper are Wax Yellow to Cadmium Yellow tinged with rose color at the base. The petals are broader than the sepals, mostly oblanceolate, their lower portion pinkish, above white or slightly tinged with yellow. Stamens, as in all Hylocerei, are very numerous; the filaments creamish and the anthers Massicot Yellow. The style is thick, Sulphur Yellow, topped by a radiating cluster of 29 Amber Yellow stigma lobes, many of them two-cleft, a character rather rarely found in the Cactaceae.

Technical color terms used are those of Ridgway, Color Standards and Color Nomenclature.

The above three species are perhaps the most widely known and cultivated of the genus, although there are many others equally as stunning in their floral raiment. We have other species growing in the Cactus House which have not flowered as yet. It may be of interest to the reader to learn that at least two of the Hylocerei produce red flowers, *H. extensus* and *H. stenopterus*, but they are rather rare in collections.

SELENICEREUS OR MOON CEREUS

In their native tropic haunts plants of the genus Selenicereus either climb up the trunks of large trees by means of aerial roots or, where there are no trees and shrubs, merely trail along the ground or hang suspended from rocks and cliffs. Members of this genus are most frequently called "Night-blooming Cereus," or by such appealing names as "Goddess of the Night," "Princess of the Night," etc. The flowers resemble those of the Hylocereus but perhaps are not quite as succulent, nor do they possess such large conspicuous foliaceous scales on tube and ovary. Another distinguishing character is the long hair that grows out of the axils of the small scales on the ovary and perianth tube, along with bristles and felt. The stems are more slender than in the Hylocerei and mostly cylindrical and ribbed; the areoles are usually slightly elevated on small knobs and sometimes bear minute spines. The large reddish fruit is covered with clusters of spines, bristles, and hairs. All Selenicerei are highly prized ornamentals and great favorites with amateur gardeners. The plants grow easily and rapidly in a tub provided with a trellis, where the stems soon become a tangled mass if not properly tied to the support. A juice extracted from the stems of S. *grandiflorus*, S. *coniflorus*, and allied species is prepared as a heart tonic and generally used by homeopathists. In St. Louis one pharmaceutical firm has been manufacturing "Cactina Pillets" for fifty years while another concern has been making "Cactegus," both products containing alkaloids from the stems of the Mexican Selenicereus.

The oldest known species is *Selenicereus grandiflorus*, a West Indian endemic with flowers 7 inches or more long. Linnaeus first described it in 1753 as a Cactus; Miller in 1768 as a Cereus; and Britton & Rose in 1909 as Selenicereus. The commonest species in present-day collections, however, seems to be S. *pteranthus*, popularly known to old collectors as *Cereus nycticalus*. Its stems are snake-like, bluish green often tinged with purple, strongly 4-angled, bearing in their areoles small conical black spines. The flowers appear in June and complete their blooming cycle within one month. It might be added that they are highly susceptible to daylight and close with the approach of dawn even on days that tend to be cool or cloudy; at least this has been the case at the Missouri Botanical Garden since 1931. The

blooms of S. *pteranthus* average 11 inches long. The outer perianth segments or sepals are linear, about 3½ inches long, yellowish with reddish tints, while the outermost are dull bronze-colored to purplish brown; inner perianth segments or petals are pure white, spatulate-oblong with acuminate tips. Stamens are very numerous, greenish to cream-colored, the upper row upturned slightly at the tips where the anthers appear, shorter than the unequal, elongated lower stamens which recline on the side of the tube and are attached along its inner face for 2¾ inches. The style is creamish color, light green at the base, 9½ inches long, and supports about 15 linear, yellowish green stigma lobes at the apex. Long white silky hairs and bristles are borne in the axils of the tiny red-tipped greenish scales that cover the ovary and the furrowed floral tube.

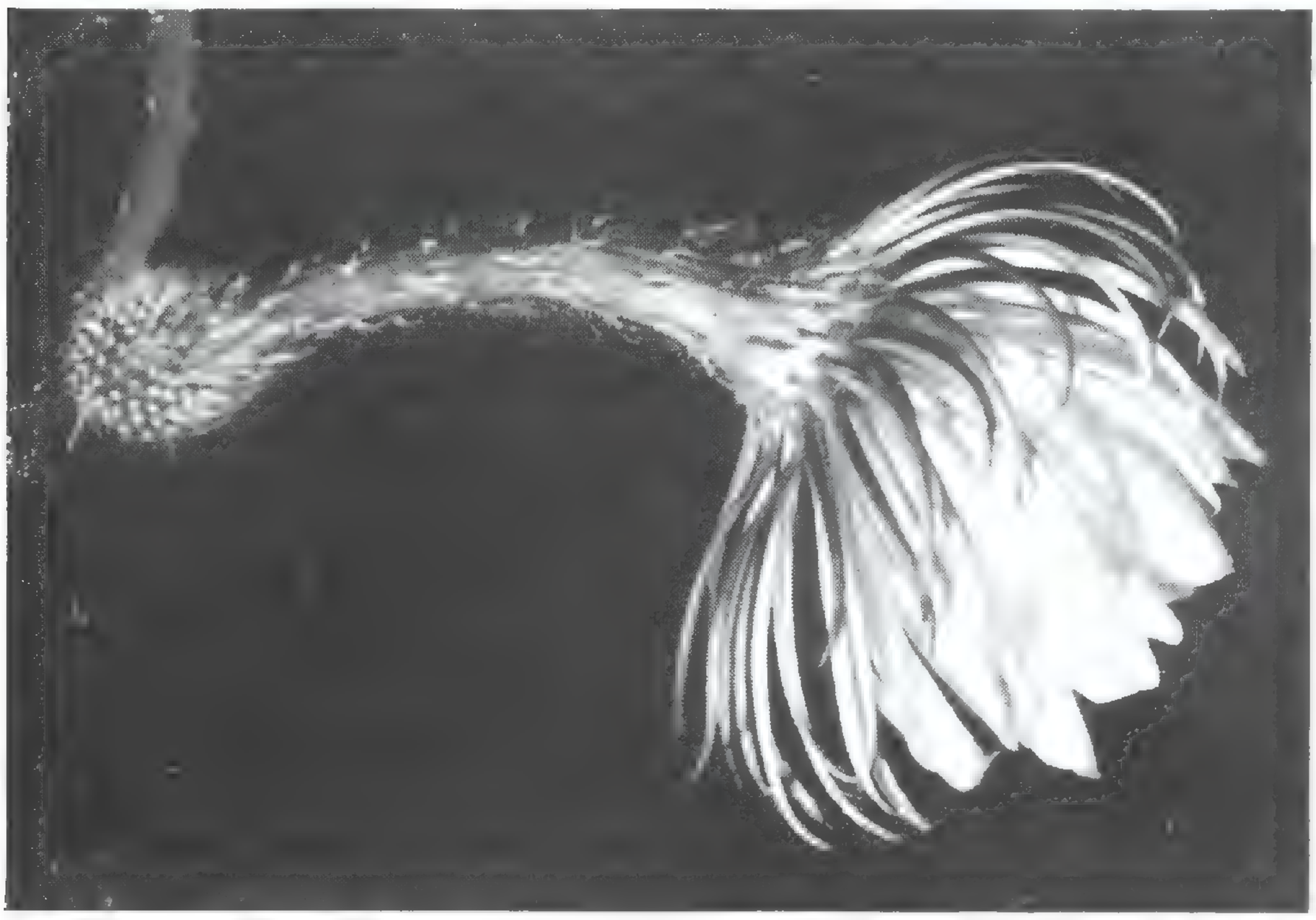

Fig. 7. *Selenicereus pteranthus.*

Of the other Selenicerei, some flowers are larger than others and the outer floral envelopes may have varying shades of yellow, green, or purple while the hairy ornament may also differ in color. Generally the species are practically identical but may be distinguished by the vegetative characters and areole armament. At least 20 species are recognized by most authorities. The Garden's collection of Selenicerei is not too exhaustive although a representative lot is being grown, including S. *grandiflorus*, S. *coniflorus*, S. *hondurensis*, S. *pteranthus*, S. *Donkelaarii*, S. *Boeckmannii*, S. *Macdonaldiae*, S. *vagans*, and several others whose identity is still shrouded in doubt.

Fig. 8. *Selenicereus Macdonaldiae*

Fig. 9. *Acanthocereus pentagonus.*

ACANTHOCEREUS OR THORN CEREUS

An Acanthocereus plant is to be found in practically every cactus collection. The plants are usually weak, elongated, and many-jointed, while their funnel-shaped, night-blooming white flowers are usually large and rather beautiful. Young growth is often terete, ribbed and soft-spiny, while mature stems are often strongly 3-angled and stiff-spined. New growth is so puzzling that many people ask whether the plants are grafted.

One of the oldest known species is the variable *Acanthocereus pentagonus*, which was described meagerly by Linnaeus in 1753. Stems at first are erect, but, being weak, soon make arches and root wherever they strike the ground. Permitted to grow like this outdoors in warm climates the plant will form large colonies or thickets in a short time. Young growth has 6 to 8 low ribs and the ridges produce areoles with numerous short acicular spines. Adult growth is 3- to 5-angled with conical to subulate spiny armament. Several races are reported, and some authorities separate them into two or three distinct species. *A. pentagonus* is commonly called "Barbed-wire Cactus." Its flowers are about 7 inches long, the floral tube and ovary greenish blue bearing a few conspicuous areoles with tannish felt and several small varicolored spines. Sepals are light green; petals white, narrow, ¼

Fig. 10. *Acanthocereus occidentalis.*

Fig. 11. *Acanthocereus Pitajaya* (*A. colombianus*).

inch wide. Stamens are very numerous, the filaments white, the anthers pale yellow. Style is 6 1/4 inches long, creamish, topped by twelve similar-colored stigma lobes. This and *A. floridanus* are the only Acanthocerei that are found wild in the United States.

Another fascinating species is *Acanthocereus occidentalis* from the western coast of Mexico. It bears flowers nearly 9 inches long, the tube and very small ovary taking up more than three-quarters of its length. The tube expands into a wide throat and is filled with a mass of erect stamens 1 to 2 inches long, the filaments being white and the anthers Buff Yellow (Ridgway). From the center of this mass protrudes a thickened style, the apex divided into 13 linear, pale Chalcedony Yellow stigma lobes. The petals are ensiform, white or slightly tinged with light yellowish green toward the tips, sometimes also flushed with pink. Throat scales are lanceolate, Calla Green, up to an inch long, while the sepals are linear, acuminate, lighter in color and nearly 2 inches long.

Still another handsome species is *Acanthocereus colombianus* from northern South America, but, according to Dr. Croizat of the Arnold Arboretum, this name was reduced to synonymy under *A. Pitajaya* in 1943. The flower is one of the largest in the Cactaceae, measuring up to a foot in length. The floral tube and throat are approximately 9 inches long, light green (Bice Green) on the outside, slightly ridged. Petals number about 40, white, the innermost being somewhat shorter. Sepals are longer than the petals, brown-green to light green or flushed with pinkish brown in the middle. Stamens, which are attached to the wall of the tube about 3 1/2 inches above the ovary, possess white filaments and light yellow (Naples Yellow) anthers. The style is slender, white, 9 inches long, and bears at the top 13 cream-colored stigma lobes. Other species are cultivated and admired for their ornamental value.

ERIOCEREUS AND HARRISIA

These two genera are very much alike, the chief distinguishing features occurring in the fruits. The Eriocerei are usually vine-like and trailing or procumbent, with red and dehiscent (splitting) fruits. Harrisias, on the other hand, are mostly semi-erect with yellowish or orange-red fruits that are indehiscent (not splitting). The Eriocerei, of which there are about eleven common species, have their home in South America, south of the equator. Harrisia is native to Florida, the Bahamas, and the West Indies.

The most popular species of Eriocereus seems to be *E. Martinii* from Argentina. It is a clambering, night-flowering vine whose stems attain a length of many feet. Adult and young growth is 4- to 6-angled, dotted with conspicuous circular areoles from which a stout, straw-colored, black-

tipped spine protrudes. Flowers average about 9 inches long and are quite odoriferous. They are borne singly at areoles near the ends of the long branches. The ovaries are tuberculate and bright green, maturing into crimson-red fruits which are produced abundantly and adorn the dark green stems for many months. The sepals are lanceolate, light green, often flushed with red or pink at the tips. Petals are oblanceolate to obovate, white with a greenish base or flushed with pale green through the middle. Stamens appear in two series, the inner ones being the longest and attached to the tube all the way up to the throat, while the outer ones are attached to the mouth of the throat in a single row. Style is 7 inches long, light green, topped by 12 linear, obtuse, deep Seafoam Green stigma lobes. The seeds of this species germinate very easily and the seedlings grow rapidly, producing flowers within five or seven years.

Fig. 12. *Eriocereus tortuosus.*

Eriocereus tortuosus likewise hails from Argentina. Adult stems are stout and very spiny. Flowers measure about 7 or 8 inches long, and have a tendency to remain open on cool cloudy days for several hours. Ovary is tuberculate, deep Grape Green with minute purple (Ridgway's Corinthian

Purple) scales bearing whitish hairs in their axils. Flower tube and throat are slightly lighter in color and often purplish tinted, their topmost scales merging into sepals. The sepals are Glass Green at the base, lighter to nearly white through the center, and usually pinkish (Pale Brownish Vinaceous) along the margins and apex. Petals are somewhat shorter, obovate in outline, pure white or faintly greenish at base. Stamens are in two series, a single row attached at the mouth of the throat and the rest all along the lower portion of the throat down the flower tube. Style is Light Turtle Green, with 14 linear, Chartreuse Yellow stigma lobes.

Eriocereus Bomplandii is a strongly 4-angled plant. Its flowers attain a size of 10 inches while the petals are far larger than those of the two species just described, being at least 4 inches long. The inner two rows are pure white except for the base, while the outer are Pale Glass Green throughout. The sepals are light green, those outermost often tinged slightly purple-brown at the tips. Stamens in two series, the lowermost attached to within a half inch of the ovary. Style is light green (Light Lumiere Green) with 16 light yellow (Barium Yellow) stigma lobes.

Most of the Harrisias are upright-growing cacti and ideal greenhouse pets producing blossoms in abundance. Three species, *H. aboriginum*, *H. fragrans* and *H. Simpsonii*, grow wild in Florida; *H. Earlei*, *H. eriophora*, *H. Fernowii* and *H. Taylori*, in Cuba; and the rest in Jamaica, Puerto Rico, and the Bahamas.

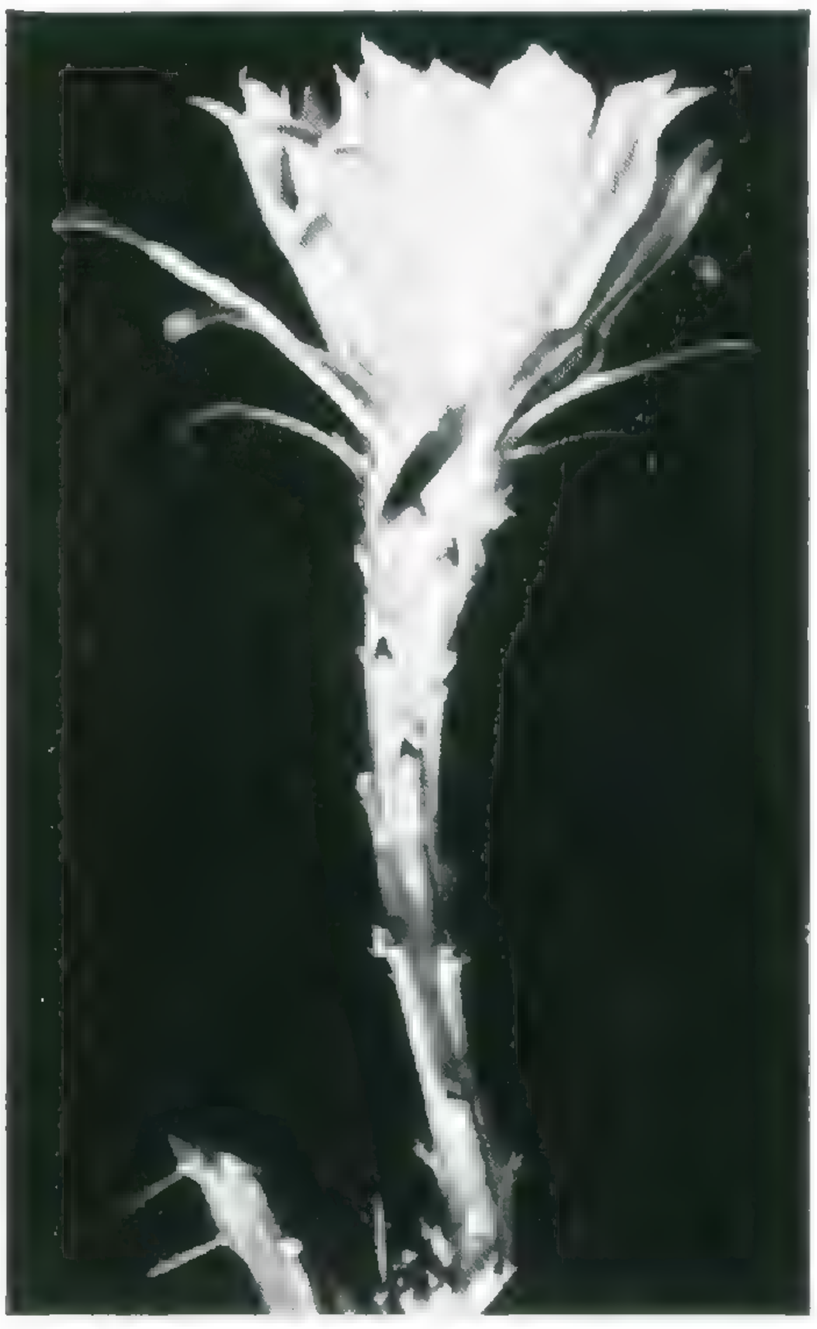

Fig. 13. *Eriocereus Martinii.*

Fig. 14. *Mediocactus coccineus.*

OTHER SLENDER, CLAMBERING OR SEMI-ERECT TYPES

Monvillea Cavendishii is one of the most prolific nocturnal bloomers in the Garden. Flowers make their appearance in early April and continue to bloom way into September. The plant is more or less branched with stems cylindrical and quite spiny. The flowers are white, up to 5½ inches long, borne towards the tops of last year's growths. The sepals have a reddish or greenish hue while the petals are pure white. Stamens have white filaments and creamish tan anthers. The white style, a trifle longer than the stamens, has 12 to 14 white stigma lobes. The fruit is a glabrous, spineless, reddish

Fig. 15. *Monvillea Cavendishii.*

"apple" about 2 inches long, which contains edible white pulp sprinkled with a great number of shining black seeds. *M. Cavendishii* is the most popular and best known of the group. *M. Lauterbachii* is a delightful partner, possessing medium-sized flowers which are quite dazzling. Sepals are greenish with lighter margins while the petals are entirely white. The slender whitish green style with its 16 linear white stigma lobes protrudes from a circular mass of stamens.

Nyctocereus is a slender-stemmed, many-ribbed, spiny genus of ornamental cacti growing wild in Mexico, Guatemala, and Nicaragua. The best known of its five species is *N. serpentinus*, which first came into prominence at the beginning of the nineteenth century. Many know it as the "Snake Cactus" or "Serpent Cactus" on account of its stems which clamber through bushes, over walls, or creep and hang in snake-like fashion. Flowers of this night-blooming Cereus are white and attain a size of 7½ inches. Its stems serve as excellent grafting stocks.

Mediocactus is a South American genus containing two species of epiphytes, but only one, *M. coccineus*, is in cultivation. In vegetative character it looks much like a Hylocereus, but the flowers are shaped more like those of a Selenicereus without the hairs on tube and ovary. The flower is large, funnel-formed, somewhat fragrant, at least 10½ inches long; sepals linear, bright green, widely spreading; petals semi-erect, oblong to obovate with serrate apices, white; stamens numerous, creamish yellow with identically colored exserted style bearing at its top 15 linear, light greenish stigma lobes.

Weberocereus is a genus of Central American cacti with stems resembling a slender Hylocereus, or, better still, a form of Rhipsalis. Only three species are known, and these possess rather insignificant blossoms of light pink, rose color, or white.

Werckleocereus is another Central American genus of epiphytic habit, much resembling a Hylocereus. However, it may be distinguished by its medium-sized, short, funnel-form flowers which bear many blackish-spined and black-felty areoles on ovary and flower-tube. Unfortunately, both of these genera are rarely found in collections in this country.

Wilmattea also hails from Central America. Its slender stems resemble those of Hylocereus, but its flowers are much smaller with a narrow limb and with a very short tube. There is only one species, *W. minutiflora*, and it grows in Guatemala and Honduras.

Strophocactus is a rare Brazilian genus of one species (monotypic) which inhabits swampy forests of the Amazon region. Its flat, Epiphyllum-like stems twist about the trunks of trees and produce elongated, large flowers that resemble those of Selenicereus. *Strophocactus Wittii* is not in cultivation anywhere, but a novelty which should be re-introduced.

Neoevansia, another monotypic genus proposed by William Taylor Marshall to contain the puzzling *Cereus Diguetii*, possesses dahlia-like tubers and slender, pencil-like stems resembling Wilcoxia, but the flowers are nocturnal like those of the Peniocereus. It grows under trees and shrubs in southeastern Arizona and in Mexico. Blooms are large, white or tinged with pink, and fragrant.

STOUT, COLUMNAR, NOCTURNAL CEREI

Lophocereus is an interesting genus native to Mexico and southern Arizona. The generic name, signifying crested Cereus, refers to the bristly top of the flowering stem which is columnar and quite stout. Because of the long bristles on the fertile joints it is sometimes given the name "Whisker Cactus." The most sought-after species is a monstrose form commonly known as the "Totem Pole Cactus." Its flowers are rather small, about 1½ inches long, opening early in the evening and closing the following morning.

The genus Trichocereus contains many types of growth habit. Quite a few of the species grow as low bushes; some are prostrate and form dense thickets; while a few assume gigantic proportions. The stems are usually characterized by many ribs, thickly set with areoles and usually very spiny. The large, nocturnal, funnel-shaped flowers are mostly white, often highly fragrant. About 28 species are recorded from the Andes Mountains of South America. Some of the species, as *T. Spachianus*, are used as stock in grafting, but with us they have a tendency to rot if not carefully watched.

The genus Lemaireocereus boasts some very tall cacti. Most of them branch from the base or from low trunks, the branches growing erect in closely set fashion remindful of the pipes of an organ. Most of the species bear flowers that open during the day, but there are a few, *L. hystrix*, *L. quevedonis*, *L. Carturightianus* and *L. Standleyi*, for example, with nocturnal blossoms. More than 20 species of Lemaireocereus are listed, each one highly ornamental. Their range of distribution extends from southern Arizona through Mexico to Peru and Venezuela and into Cuba. The stems of all are unexcelled as stock for grafting the globular kinds of cacti.

Eulychnia is a Chilean genus of four species inhabiting dry hills. In some parts of the Chilean deserts these form the dominant feature, but as yet they are not plentiful in American collections. The white or pinkish flowers are both diurnal and nocturnal.

Facheiroa is a rare Brazilian and Peruvian genus of bushy habit not well known in collections as yet. It is much branched and very spiny, its nocturnal flowers borne on a cephalium (head) consisting of a compact mass of reddish brown wool or hair. The flowers are very small and white.

Zehntnerella is a tall, slender, much-branching genus from Brazil. Only one species, Z. *squamulosa*, is known to exist and it is rarely seen in collections. It is said to produce very small white nocturnal flowers with many long hairs inside the throat.

Binghamia is a bushy, more or less branched Cactus with the habit of Trichocereus, but lower and with smaller, white, nocturnal flowers. The

genus is confined to Peru. The few species are of slow growth and very shy bloomers.

Browningia is one of the most grotesque genera in the Cactaceae. It contains a lone species, *B. candelaris*, which grows at high altitudes in Chile and Peru. Specimens produce a single upright trunk with curiously spreading or drooping branches at the top. The funnel-shaped flowers are a little curved, nearly white, and open in the evening.

Cephalocereus and Pilocereus are two closely allied genera with members native to Florida, Mexico, West Indies, Guatemala, Colombia, Venezuela, Brazil, Peru, and Ecuador. For the most part, they are tall, erect, and columnar, with small bell-shaped flowers. The most outstanding species is *C. senilis*, the famous Old Man Cactus of Mexico which every Cactus fancier desires to possess.

Stetsonia is a monotypic genus of Argentina with large nocturnal flowers produced on the upper part of the branches. The tree attains immense proportions and is much branched. It is an extremely slow grower but small plants are plentiful and available in the trade.

Arthrocereus and Leocereus are rather rare Brazilian genera infrequently, if at all, seen in collections.

Dendrocereus is a Cuban genus, its one species, *D. nudiflorus*, being a thick-trunked, many-branched tree with large white flowers. Our original specimen was damaged severely during the hailstorm of May, 1927, but it flowered and fruited before it died a few years later and seedlings from it have been established. The plant is still rare in collections.

The stately but thorny Carnegiea, called Saguaro in the Southwest, is one of the largest and noblest of all cacti. It towers majestically, with raised, candelabra-like arms, above all other desert vegetation. Only one species, *C. gigantea*, exists, and it is plentiful in Arizona which state has adopted the flower officially. The trunk and branches of the Saguaro are fluted and armed with stout spines set in long straight rows. In late spring white waxy blossoms adorn the tips of the stems, growing singly but close together and giving a beautiful clustered effect.

The genus Cereus contains nearly 30 species most of which are upright, tall, and much branched. These are the true Cerei, technically speaking, and are distributed throughout tropical America. The best flowering species in our collection is *C. validus*. Its slender branches reach the roof of the Cactus House and produce several hundred blossoms during the summer season. The fruits, which are produced copiously, have a habit of splitting while still attached to the branches, revealing the rich crimson pulp within.

Visitors who are not acquainted with cactus flowers often refer to the colorful dehiscing fruits as flowers.

The night-blooming Cerei, on the whole, are easy to manage and one or two forms should be included even in the humblest of collections. Watching the lovely blossoms unfurl their immaculate petals is a thrill of a lifetime and you will invite your friends to enjoy this rare spectacle with you. A cactus fan thinks that such dazzling beauty and fragrance can be found in no other plant.

PLANTS OF THE SEASON

AN EARLY-FLOWERING JAPANESE CHERRY

It seems a pity that one of the loveliest of all flowering trees should be so little known. *Prunus subhirtella* var. *autumnalis* is an early-flowering Japanese Cherry and a distinctive one in several ways. Now that it is being offered for sale by progressive nurserymen, it should be planted more, particularly if specimens can be obtained which have been budded on an appropriate rootstock. As its varietal name implies, this charming little tree sometimes blossoms in the fall after the leaves are shed. A specimen has been grown in a St. Louis garden for five years, and during that time it produced at least a few flowers every autumn but in only one year did it have enough to be effective in the landscape.

Autumn-flowering is not the only peculiar habit of this interesting variety, however. Its flowers are slightly double, though not enough so to look grotesque and artificial, even when used in a flower arrangement and seen close at hand. Their development on the twig is also peculiar and they come into flower a few at a time. As a consequence, *Prunus subhirtella* var. *autumnalis* stays in flower fully twice as long as any of the other early-flowering cherries, and during most of that time it has a delicate play of color due to the mingling of pinkish white flowers and deep pink buds. As they develop, there is a most fascinating shift of color changes. Its first flowers open among the bare branches at the same time as the early daffodils. Gradually it comes into fuller bloom until it is a mass of pink and white. Then the leaves begin to come out and during the end of its blooming period it is a mixture of delicate pink and pale green.

Though this plant has long been known in the Orient, it did not flower in American gardens until 1909 and has only recently been offered in the trade.

E. A.

AZALEAS

This year the azaleas were the most colorful of the shrubs in flower during the second half of April although their normal blooming period is usually in May. The most brilliant of the deciduous azaleas are *Rhododendron japonicum* and the so-called *mollis* hybrids which have a color range from pale yellow through orange, apricot, salmon to a near-rose color. They grow to a height of about 6 feet and readily adapt themselves to our alkaline soil.

The Snow Azalea, *R. mucronatum*, listed as *Azalea ledifolia* in the catalogues, has the same blooming period as the *mollis* hybrids. This is an exceptionally fine semi-evergreen plant with single, white flowers about 2 inches across, borne in such profusion as to entirely hide the leaves. In habit of growth it forms a broad mound about 4 feet high and 6 or more feet wide. A lavender companion, also evergreen, is the Korean Azalea, *R. yedoense* var. *poukhanense*. Still another is the Mayflower Azalea or Rosy Pinxterbloom, *R. roseum*. The rose-colored flowers are small but are so numerous as to cover the whole plant just as the leaves emerge. A week later the closely related *R. nudiflorum* comes into bloom. The flowers are a very pale pink and not nearly as attractive as those of *R. roseum*.

During the past ten years all of the azaleas described have bloomed freely each year in their present location in the Garden near the Grove. They have done remarkably well and are recommended as very good shrubs for this locality. It is commonly supposed that Azaleas and Rhododendrons are difficult to grow because of their exacting requirements. This is true for some kinds but the deciduous and semi-evergreen species mentioned above will flourish in this climate. They grow best in full sun if they are given a heavy mulch of oak leaves or sawdust and are copiously watered during drought periods. (See May, 1941, Garden BULLETIN).

P. A. K.

A FINE CHINESE LILAC

The first few days of April ushered in a notably successful season for lilacs. Looking forward to even greater enjoyment from these Balkan and Asiatic favorites we should like to call attention to the Little-leaf Lilac *(Syringa microphylla)*. The specific name refers to the small leaves which are about half the length of those of the common S. *vulgaris* and nearly round in outline. Although plants of this species grown from seed collected by William Purdom were introduced into this country as early as 1913 their potential value has still been far from realized, at least in this region.

Experimental plantings of *Syringa microphylla* at the Garden have been attended with considerable interest for the past two decades—long enough

White wood hyacinths planted among *mollis* hybrid azaleas present a very effective combination.

Common Large-flowered White Lilac "Jan Van Tol"

Little-leaf Lilac *(Syringa microphylla)*

to leave no doubt of its possibilities in St. Louis gardens. A group on one of the knolls produced an especially fine display this season. Neither the individual flowers nor the sprays are as massive as those of the widely planted *Syringa vulgaris*, yet the combination of their abundance, distinctive delicate appearance, and fragrance makes them second to none. Perhaps the most attractive single feature of S. *microphylla* lies in the distribution of the light pinkish lavender sprays over the entire plant instead of only near the top as is so common with lilacs. This species is suitable for any shrub border and is not particular about the kind of soil as long as it is reasonably fertile.

At the Arnold Arboretum, where the early experimental work was done, *Syringa microphylla* is reported to flower in October as well as in the spring. This season plants at the Garden were in full bloom from April 10 to 16, coming a full week or ten days later than many of the early-blooming lilacs. Since everything is about two weeks ahead of schedule this year they might be expected ordinarily to bloom during the latter part of April. The Little-leaf Lilac is native to the north-central Chinese states of Kansu, Shansi, and Shensi, bordering on Inner Mongolia. H. N. A.

THE HARDY ORANGE

The Hardy or Trifoliate Orange, *Poncirus trifoliata (Citrus trifoliata)* is one of those semi-tender shrubs which will do well in St. Louis if planted in exactly the right location. In the Arboretum, at Gray Summit, the bushes were planted along the north side of one of the greenhouses. In this site they get a little extra warmth on cold nights, and the northern exposure prevents the flower buds from opening too early in the spring. The Hardy Orange is a true citrus fruit though so bitter as to be quite inedible. The attractive waxy white flowers are succeeded by brilliant orange fruits no larger than a small walnut but quite spectacular when seen against the dark green twigs. In the south it is frequently planted as a hedge plant (as, for instance, at Thomas Jefferson's old home at Monticello) but in St. Louis it is only for the lover of novelties who can give it the special care it requires in this climate.

A few decades ago the Hardy Orange came into prominence in connection with experiments in hybridizing citrus fruits, carried on in the southern states by the Department of Agriculture.* As a result of crosses made between the Hardy Orange and the Sweet Orange, a new fruit, the Citrange, was created. The Citrange combines to some extent the hardiness of the Trifoliate Orange with the more favorable edible qualities of the Sweet Orange. Even so, the fruits are smaller than those of the latter and not their equal for table use.

*See Yearbook of the Department of Agriculture for 1904.

Although these experiments did not produce as ideal a citrus fruit as might be desired for the southern states the Citrange did prove useful in the preparation of preserves and jellies, as an "ade" drink, for flavoring, and even as a fresh table fruit if sufficient sugar is added. E. A.

YOUR QUESTIONS ANSWERED

During the course of a month the Garden handles a vast number of gardening problems and questions that come in from all quarters. Beginning with this issue of the BULLETIN we will present our answers to as many of these questions as possible, selecting those that are most frequent, of current interest, or otherwise of special note. It is hoped that this feature will not only serve to place such information on permanent record, but will be an aid to our readers and stimulate greater interest in the facilities and services of the Garden.

When should iris be transplanted?

The common bearded iris may be transplanted any time after the flowering period, although if it is done during June, July, or August satisfactory blooms may be expected the following spring. Lift with a spade and carefully split apart the overgrown clumps, cutting away the older, partially decayed portions. Iris are rapid growers, so allow for expansion when transplanting. It is best to divide a thriving bed every three or four years —why not exchange some of your choice stock with your neighbor and create a really colorful planting?

How are Philodendrons propagated?

Cut your older plants into sections, each with two to four leaves (if many plants are desired they may be cut into sections with but one leaf) and place them in a jar of water or a tray of moist sand. If sand is used make sure that at least one node (the place where the leaf is attached to the stem) is well below the surface of the sand for it is at this point that new roots develop. When the roots are established, which will take about 4 to 5 weeks, the cuttings may be transplanted to small pots. Old Philodendron plants eventually get straggly, that is, the basal leaves tend to die away. The best procedure is to cut them up and start new plants; or if only the original plant is desired the stem may be cut back close to ground level and new ones allowed to sprout.

When should lilacs be fertilized?

Spring is the time to apply fertilizer to lilacs, as that is the time foliage and flower buds for next year are being formed. If lilacs (or most any other shrub) are fertilized in the summer, the result probably will be tender succulent growth produced too late for proper "hardening off" to survive the winter in good condition. The best fertilizer for lilacs is well-rotted manure spread liberally beneath the stems to a depth of 2 or 3 inches. This can be left on the surface of the ground during the summer when it will act as a mulch to discourage weeds and to conserve moisture. Early *next* spring cultivate the old manure into the soil, and add a new mulch. If manure is hard to obtain, a mulch of partially rotted leaves may be added, and then watered once or twice during the season with about a gallon watering-pot full of water to which has been added, and well mixed, a heaping tablespoonful of Vigoro. Unless you are sure your soil is not acid, it might be well to lightly cover the ground beneath your lilacs, sometime during the summer, with ground limestone or hydrated lime. Then water thoroughly.

I have a "Mother-in-law Tongue" plant that is flowering. Is this a rarity?

No. It is true that Sansevierias may not bloom frequently in the home but once they start they usually will continue year after year. At the Garden our Sansevierias put forth flowers several times during the year and bear seed copiously.

Can Camellias be started from slips?

Before the root-promoting substances became available it was rather difficult to root Camellias from cuttings but it is now possible to induce roots to form in from two to four months if the hormone powders are used. The length of time required for rooting is dependent upon the time of the year the cuttings are made and the variety. Camellias produce new wood after the plants have flowered in mid-winter. When this wood becomes firm, in May or June, it is in the best condition for rooting. While it is possible to root some of the varieties at a later date, it will be found advisable to make the cuttings before the flower buds are formed, which will be about June in this region. Make the cuttings 5–6 inches long and leave at least 3 leaves. After dipping the moistened end of the cuttings in one of the hormone powders insert them in a pan in a mixture of 1 part peat and 2 parts sand. Keep the rooting medium moist at all times and shield the cuttings from the sun and wind in a glass box or miniature greenhouse. After 10 weeks lift several cuttings to determine the extent of rooting. If well rooted, pot in a mixture of soil, peat, and sand and protect the plants from drying winds. Camellias grow slowly and will not begin blooming until they are three or more years old.

Of what value are wood ashes as a fertilizer?

Wood ashes contain potash and lime in varying amounts, depending on the type of wood and the extent to which they have been exposed to the leaching action of weather. Unleached hardwood ashes may contain up to 10 per cent potash, softwood ashes as low as 2 per cent. Wood ashes should be stored in a dry place and applied in the spring or summer, using about 5 pounds per 100 square feet.

How may ants be most effectively controlled?

Destroy ants in their nests by applying carbon bisulphide early in the evening. Pour one tablespoonful of the liquid into the opening leading to the center of the nest, then cover the hole with a stone or board. Repeat this treatment several times if necessary.

Various commercial preparations are on the market that can be used to advantage if handled properly. These are poison baits that kill all types of ants that can be encouraged to eat them.

Dusting the ground with rotenone dust (if you can obtain it) has proven quite effective —and incidentally this has been found to be an excellent control measure for pill bugs.

Is it worth while to grow peach trees from seed?

No, seedling peach trees seldom produce quality fruit. Plant breeders develop new varieties by growing seedlings, but the ancestry is known and the hybridizing is controlled.

Tree roots are damaging my sewer pipes. Is there anything that can be put around the pipes to keep the roots away?

There are patented preparations on the market which are supposed to prevent tree roots entering a pipe joint. These work only as long as the joints remain absolutely tight. After a few years no vitrified clay pipe joint is tight because of misalignment due to settling of the soil.

NOTES

A recent letter from Dr. Louis O. Williams, former graduate student at the Garden who has been engaged in rubber investigation for the past several years, states that his headquarters are now at Belo Horizonte, Minas Gerais, Brazil. In November he and Mrs. Williams had attended an orchid congress at São Paulo, of which he wrote enthusiastically.

Dr. Edgar Anderson, Geneticist to the Garden, was in Portland, Oregon, from April 21–25, advising the Oregon Bulb Farms on their breeding work with narcissi and hybrid lilies. This firm has not only carried on an extensive breeding program, but has kept complete and accurate records, permitting a more exact genetic analysis than is usually possible in such cases.

Among the orchid or water-lily fanciers visiting the growing greenhouses at the Garden recently were: Mr. Valentino Sarro, of New York City; Dr. Henry H. Turner, of Oklahoma City, Okla.; Mr. C. J. Bourgondien, of Babylon, Long Island, N. Y.; Prof. Alexander Laurie, Professor of Horticulture, Ohio State University, Columbus, Ohio; Mr. W. T. Innes, of Philadelphia, Pa.

Visitors to the Garden library and herbarium during April included the following: Dr. Carl O. Sauer, Chairman Department of Geography, University of California, Berkeley, who, under the auspices of the Rockefeller Foundation, is spending a year in an investigation of North American food plants; Mrs. James McClure, of Washington, Mo., writer on horticultural subjects; Mrs. F. W. Schoettler, of Louisville, Ky.; Dr. I. E. Melhus, Head Section of Botany and Plant Pathology, Iowa State College, and Dr. Charles E. Friley, President Iowa State College, Ames; Prof. Pablo Martinus del Rio, Professor of Ancient and Medieval History, Universidad Nacional de Mexico, Mexico, D. F.; Dr. Rogers McVaugh, Associate Botanist U. S. Department of Agriculture, Beltsville, Md.

Though few gardeners or botanists are sensitive to the difference, there are two basic kinds of tall bearded garden irises. There are a few *Iris germanica* varieties which flower a little in advance of the newer hybrid irises and are therefore important in a season such as this which has been rainy and cold during all of April. The *germanicas* are old-fashioned and are ordinarily available in only three or four color forms, but they are sturdy and dependable in even the worst of Missouri springs. In a warm April they precede the modern hybrid sorts by only a few days, but this year gardens which did not include one or two of these old-fashioned sorts were bare of bloom for at least a fortnight. One of the best of these in St. Louis gardens is an ancient variety variously known as "Midnight" or "Kochi." It is a rich dark purple, of medium height, very floriferous, and strong enough to do well in the semi-shade and soggy soil of a city back-yard.

The following papers, read at the conference on "Gene-Action and the Micro-organism" held at the Garden on February 2 and 3, have been published as the April number of the ANNALS OF THE MISSOURI BOTANICAL GARDEN (Vol. 32, No. 2):

Mendelian and Cytoplasmic Inheritance in Yeasts . . . . . Carl C. Lindegren
Biochemical Genetics of Neurospora . . . . . E. L. Tatum and G. W. Beadle
Genetic Aspects of Changes in *Staphylococcus aureus* Producing Strains Resistant
to Various Concentrations of Penicillin . . . . . M. Demerec
The Physiology and Genetic Significance of Enzymatic Adaptation . . . S. Spiegelman
The Mechanism of Radiation Effects and the Use of Radiation for the Production
of Mutations with Improved Fermentation . . . . . A. Hollaender
The Influence of Nucleic Acid on Dehydrogenase Systems . . . . . .
. . . . . J. P. Greenstein and H. W. Chalkley
Genetic Aspects of Virulence in Bacteria and Viruses . . . . . John W. Gowen
Gene Action in Paramecium . . . . . T. M. Sonneborn
Spontaneous Mutations of Bacteria . . . . . M. Delbrück
Genetics of Bacterium-Bacterial Virus Relationship . . . . . S. E. Luria
Genetics as a Tool for Studying Gene Structure . . . . . S. Emerson
Discussion.

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

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MISSOURI BOTANICAL GARDEN BULLETIN

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Cover: Climbing roses (var. "Roserie") on the north side of Linnean Garden.

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HOME-GROWN GARDENIAS

DAVID C. FAIRBURN

No house plant, except maybe the African Violet or an Orchid, is prized as highly as a Gardenia in bloom. The exotic beauty and fragrance of the flowers, combined with a sense of horticultural achievement in producing a respectable-looking specimen, leave little to be desired. Relatively few indoor gardeners ever experience such satisfaction, however, and this is not from any lack of cultural effort or initiative. Judging from the constant stream of inquiries that come to the Garden, it is apparent that Gardenias frequently suffer from too much tender care and unique prescriptions such as a tablespoonful of kerosene applied at weekly intervals.

Having raised two Gardenia plants *(Gardenia Veitchii)* on the family window-sill last year, and harvested a total of five flowers, three of which opened at the same time in March, the writer has come to the inevitable conclusion that he is quite an authority on the subject. So by following directions carefully and having a compost pile handy in which to bury mistakes, maybe you can soon become a Gardenia expert too!

It is essential to start with strong, healthy plants; otherwise the case is hopeless. Weak, chlorotic specimens are difficult to revive even in a greenhouse. Vigorous, young plants, about one year old from cuttings, offer the best possibilities.

Now let us assume that the Gardenia arrives as an Easter gift. Since this plant is susceptible to frost injury, it must remain indoors until the weather is reliably warm, which means May 1 to June 1 in St. Louis, depending on seasonal deviations. Keep the plant in, or at least near, a south window where it will receive direct sunlight. Turn the pot occasionally to prevent the growths from leaning towards the sun. Moisture and temperature are very important cultural items. Never let the soil dry out until it feels like concrete, and give the plant a daily shower of cool water in the bathtub to remove dust and help keep the leaves and flower buds firm. Gardenias are

native to the sub-tropical regions of the eastern hemisphere, and consequently they prefer a warm growing temperature of 70° F. or slightly over. During summer, of course, the day temperature may go considerably higher without injuring the plants. Prolonged spells of cold, damp, cloudy weather are hard on Gardenias. Leaves turn yellow and buds drop off. On the other hand, lack of sufficient moisture in the soil and low atmospheric humidity can cause the same trouble. It is not always easy to provide the proper balanced conditions. On bright, warm spring days the plants should be moved outdoors where they will get some fresh air and possibly an invigorating spring rain.

After all danger of frost is past, select a protected spot in the garden where the plant will have partial shade from the burning sun, and sink the pot in the ground up to the rim. In case of drought add enough water to keep the soil in the pot moist; and apply a level teaspoonful of a complete fertilizer once a month. A mulch of cattle manure on top of the soil is also beneficial. Inspect the plant carefully at regular intervals to see if any mealy bugs are present. These are small, cottony insects that hide underneath the leaves and at the joints of the stems, obtaining their nourishment from the plant by puncturing the tissues and extracting the vital cell sap. They multiply rapidly and unless checked soon destroy the plant. An easy way to control these pests is to knock them off with a forceful spray of water from the garden hose. Weekly treatments of this nature will also discourage aphids (plant lice), red spiders (mites), and any other insects that may try to set up housekeeping. Pinch back (prune) all the young branches when they get six inches long. This makes the plant bushy and symmetrical.

If the environmental conditions are satisfactory, the Gardenia plant will grow considerably during the summer, and may need shifting to a larger pot before fall. If growth has been slow and the plant is not "pot-bound" (roots thickly matted around the ball of soil), repotting may be omitted unless there is some doubt regarding the fertility of the soil. A good potting soil for Gardenias is composed of about three parts garden loam containing some sod or turf, thoroughly mixed with one part well-rotted cattle-manure, one part acid peat, and one part coarse sand. A four-inch pot of bone meal mixed with each bushel of soil is also recommended. To avoid pale green, chlorotic leaves keep the soil definitely acid. Simple, inexpensive test kits for determining soil acidity may be obtained at almost any seed store, florist shop, or nursery. Plants can be watered with dilute solutions of aluminum sulphate, iron sulphate, or vinegar to obtain the desired acidity pH (about 5.0). Powdered sulphur mixed into the soil can be used for the same purpose. Ammonium sulphate or other acid fertilizers used at the rate of one

Gardenia Veitchii flowering in April

Gardenia cuttings can be rooted in a pot containing a mixture of ½ sand and ½ peat. A Bell jar retains the essential moisture.

After 8 to 10 weeks in the propagation pot the cuttings are well rooted.

teaspoonful per quart of water not only helps control the acidity but also provides essential mineral elements. Never apply lime to a Gardenia plant.

Before frost arrives bring the plant into the house and place it in a south or east window. Do everything possible to maintain high humidity, as dry air is the major cause of failure with Gardenias. Placing the pot on a tray of moist gravel will help. Pans of water on the radiators and water in the furnace reservoir also increases the humidity. When the paper starts to part company with the wall, you have just about reached the optimum humidity for growing Gardenias.

During the dark days of late fall and winter, when plants are growing slowly, no fertilizer should be applied, and the soil should not be allowed to remain constantly wet or soggy. With the approach of spring, Gardenias grow more rapidly and can use additional food elements. Liquid manure, or a teaspoonful of complete fertilizer per quart of water, applied as a regular watering at two-week intervals, should prove beneficial.

If all the cultural requirements have been adequately provided, flowers will appear on the plants from midwinter on through spring. *Gardenia florida* (Cape Jasmine) blooms during the summer, has smaller flowers than *G. Veitchii*, and is held dormant in winter by storing the plant in a cool, fairly dry place. In the southern states Gardenias can remain outdoors the year round. Several cases have been reported where the plants survived the winters of northeastern states when located in a protected spot, heavily mulched with leaves, and boxed in to prevent freezing.

Young Gardenia plants produce the best results, so two- and three-year old specimens are usually discarded after cuttings are taken from the new growths in winter or spring. Propagate only from strong, healthy plants, using tip cuttings with three to four nodes or joints. Dusting the cut ends with Rootone or some other hormone powder is an aid to root formation. Insert the cuttings 2 to 3 inches deep in a flat or pot of moist sand and peat (1 to 1 mixture). Firm well and water thoroughly. Cover the cuttings with a glass jar to obtain a humid atmosphere, and maintain a temperature of 75°–80° F. If possible, place the flat or pot where it will have mild heat from below to hasten rooting. Do not expose the cuttings to strong sunlight as the temperature inside the glass jar would soon become excessive and cause burning. When the cuttings start to root, the jar can be lifted part way to admit some air. Frequent syringing of the leaves with water is necessary. In two to three months the cuttings should be well rooted, and ready to move into 2½- or 3-inch pots containing the special soil mixture previously mentioned. Firm potting is recommended, with the surface of the soil about ½-inch from the rim of the pot to provide ample

space for watering. Keep the plants in active growth, and shift them into larger containers as soon as the roots become crowded.

Raising Gardenias in the home is not easy, but if you possess a considerable dash of "green thumb" talent, the chances of success are reasonably good. Any one can grow Philodendron or Chinese Evergreen. Be exclusive —grow Gardenias.

PHLOEM NECROSIS—A SERIOUS THREAT TO THE ELM

AUGUST P. BEILMANN

Over a period of many years we have come to regard the American Elm as the nearly perfect shade tree for both street and lawn. In the northeastern parts of the country the tree is entitled to the high regard in which it is held by tree lovers; but in the Middle West, the Prairie States, and even the drier Southwest, it can hardly be expected to flourish and provide the cool shade so much a part of New England towns and roadsides. Nevertheless, street planters and home owners in the Middle West have used American Elms for every situation. The tree usually transplanted successfully, grew rapidly at first, was never very expensive, and it could be obtained in huge quantities. Sometimes city ordinances restricted the choice of trees. In St. Louis many thousands of American Elms have been planted in the hope of attaining uniformity for the whole length of a boulevard. Along U. S. Highway 66, from a point inside the city limits to Gray Summit—a distance of nearly 35 miles—many lots of 10,000 each have been planted.

No tree, no matter how adaptable or how vigorous, can be expected to succeed in every soil or in every exposure. Most of the soils in the City of St. Louis are loessial in origin, quite deep, well drained, and relatively fertile. However, they are not uniform, block after block, in any direction, and often grading has destroyed whatever good soil should have been encountered. Drainage, exposure, fertility, and moisture conditions bear no relationship to city ordinances, and they merely complicate a planting plan devoid of imagination. In the suburban communities, where other soil types are encountered, other kinds of trees should be used. Along superhighways, where conditions change with each mile, much more care, knowledge, and foresight are required for a successful plan of tree planting.

Aside from the fact that trees should be planted where they will grow and not by ordinance or availability of planting stock, there is another reason for using more than one species along any long street or highway. The reason is simply this: if a particular kind of a shade tree is attacked

by either disease or insects and this kind dominates the planting, the results will be disastrous when that disease or insect reaches epidemic proportions. This is exactly what has happened in the past and exactly what is happening now with the American Elm throughout most of the Middle West. From Columbus, Ohio, to as far west as Kansas City, and from Chicago to central Kentucky, at least one-quarter million elms are being killed each year by *phloem necrosis*.

The disease has been known for several years. Dr. R. U. Swingle described it in 1942 (U. S. Dept. Agr. Circ. 640). He stated that it was first observed in Ironton, Ohio, in 1918, and that a similar condition was described in botanical literature as early as 1882. The first indication to the tree owner of the presence of the disease may be the death of the tree. Small elms, appearing in good health, may have all roots and most of the bark on the lower trunk killed before the leaves wilt or drop. In other cases wilting and shedding of leaves may begin as soon as the disease gains a foothold. Large trees may lose several large branches, or even all branches on one side during the course of a year. The following year the remaining portion may open leaf buds, but die in mid-summer. The disease is supposed to be caused by a virus,[1] and it can be transmitted to healthy trees by grafting infected bark, but the ordinary manner and method of spreading from tree to tree is unknown. There is no control. While some of the early symptoms resemble starvation and drought injury, neither feeding nor watering has had the slightest effect on the spread of the virus through an infected tree. Since the symptoms often resemble certain nutritional deficiencies in the early stages, every suspected tree should be carefully examined for dead and brown patches of inner bark. The disease attacks the soft inner bark (the phloem) of the trunk, roots or branches. In the very early stages, the slightly discolored phloem may have a faint wintergreen odor. This is quickly followed by the browning and complete killing of the bark. Although the manner in which the disease is spread is unknown, it is advisable to remove and dispose of all infected trees.

In the company of Dr. J. C. Carter, Assistant Botanist, Illinois State Natural History Survey, the writer spent several days in St. Louis County last September. Many infected trees were found in Ladue Village; in fact it was not difficult to find the disease in any locality where elms were growing. Some of the diseased trees appeared normal, especially those whose roots and lower trunk had been attacked. Such trees matured and shed their

[1] A virus is hard to define. It is too small to be seen under the highest magnification of an ordinary microscope and is not often isolated. It is known to be highly infectious and dependent on living tissue for multiplication and growth. Examples of virus diseases in man are measles, smallpox, infantile paralysis, etc.; in plants, mosaic disease and yellows, etc.

leaves in a normal manner last fall, but failed to open buds this spring. In others the brown bark was splitting and peeling from the trunk.

Evidently the only control lies in the development of resistant types of elms. Certainly many of our larger elms were exposed to the earlier attacks of phloem necrosis, and many of them survived. Mr. C. R. Runyan, Superintendent, Spring Grove Cemetery, Cincinnati, Ohio, feels that many of the large specimens there escaped the 1918 outbreak which was especially severe in that territory. Although many hundreds of small elms along Cincinnati boulevards are dying, and many more will die, few of the older trees are being attacked. It appears quite probable that resistant types can be found and propagated. However, if American Elms, certified as to disease resistance, find their way into nursery channels they will be much more expensive than those available now. This may be a blessing in disguise; certainly a little more thought and imagination will be required when "certified" Elms cost as much as better trees do now—it may even require a change in city ordinances!

To sum up the situation:

Phloem necrosis can be found in many towns and cities in this section. A great many, but not all, of the smaller American Elms will be killed. Some large trees will escape, many others will be killed, although the largest and oldest may suffer the least.

Any crinkling of the foliage, sudden wilting of whole branches, or peeling away of bark is to be viewed with suspicion.

Since the manner in which the disease is spread from infected to healthy trees is unknown, there is no control.

Buy no "guaranteed" protection for your trees from any one; until the vector (possibly an insect in this case) is discovered there will be no control.

A great deal of exacting laboratory and field work is needed before a control program is evolved.

Don't plant an elm now; and if you lose a tree replace it with another species—the nursery lists are long and interesting.

PLANTS OF THE SEASON

ROSA ALBA IN ST. LOUIS

Here and there about St. Louis one may find splendid specimens of a rose so ancient that its history is known only to a few, so humble that it is restricted mainly to the dooryards of market gardeners and the collections of a few discriminating amateurs. *Rosa alba* is indeed so old that the usual

Rosa alba in St. Louis

term of "old-fashioned rose" is quite out of place in describing its varieties. In the 1600's Parkinson was already referring to it as the oldest rose known to English gardens, and one who knows it well will be able to recognize its characteristic flattish blooms and bluish-green foliage in many paintings from the Middle Ages.

Two sorts are commonly found in St. Louis gardens, differing chiefly in the doubleness of the flowers. Both have white petals just barely tinted with flesh color when they first open. The "Great Double White," to use its old English name, is fully double, though not monstrously so, and when it is wide open a few stamens can be seen in the center. "Semi-plena," the other variety, has a double circle of petals and a center of stamens which are bright gold when they open, turning to dark brown the first day. The wide, bluish-green foliage is borne on stout green, arching canes 5–9 feet high. The flowers grow at the tips of short side branches so that they are spaced evenly over the whole bush. It is this regular spacing seen in combination with the wide, clean foliage and the leafy-tipped calyx which gives *Rosa alba* a certain distinctive elegance.

To city gardeners these old varieties recommend themselves quite as much by their constitution as by the simple beauty of their flowers. They are resistant to mildew and other diseases and have an amazing capacity to flourish on filled land and in soils penetrated by the roots of trees. They do not really prefer the shade but they have the ability to flower reliably, with little attention, in many sites which would be too exacting for other roses.

In pruning them one should remember that they beautify the garden by the mass effect of the whole bush. Every year a portion of the old canes should be removed after blooming time, cutting them off as close to the ground level as possible. A few awkward branches may then be cut back here and there, but the pruning shears should be used sparingly since the flowers are succeeded by bright red berries which add color to the garden during the fall and winter. In the early spring a few of the branches may show a little dead wood in some seasons, and this should be cut out as the bushes come into leaf. In shady and poorly drained locations a little black spot may develop in wet years. This is best controlled by a strong dormant spray in late winter, paying particular attention to soaking all the dead leaves on the ground as well as the canes themselves.

E. A.

AN EARLY-BLOOMING DARK RED DAYLILY

The last decade has seen a great increase in the varieties of daylilies (Hemerocallis) with dark red colors in the flowers. Some of these varieties are so dark that many people do not care for them when they are exhibited separately. Interplanted with the yellow and orange varieties, however,

they show off to good advantage and make the lighter colors look brighter by contrast. One of these new varieties, "Boutonniere," blossoms at the same time as such early-flowering varieties as "Apricot" and is particularly effective if planted near it in the perennial border. Like most of the daylilies, it grows well in sun or in semi-shade and will even do well in a city back-yard garden.

E. A.

AN EVERGREEN FOR SHADY GARDENS

Certainly two of the most vexing garden problems in St. Louis are: satisfactory plants for shady spots, and evergreens that will be presentable throughout the year. The Japanese Andromeda *(Pieris japonica)* offers a

Japanese Andromeda *(Pieris japonica)*

notable contribution toward the solution of both. Plants have been grown successfully for some few years at the Garden flanking the south entrance of the Mausoleum. The leaves are rather small, shiny dark green, and borne in sufficient abundance so as to present a compact dense spot of verdure in the garden the year 'round. In late winter or very early spring they send

out numerous drooping sprays of small, waxy white flowers. Preceding, as they do, the Narcissi and Forsythia they are truly a "pre-harbinger" of spring. Like other Ericaceous (Blueberry family) plants, they require an acid soil and plenty of humus.

In a recent issue of *The Home Garden* magazine the Japanese Andromeda is referred to by Donald Wyman as one of the finest of evergreen shrubs for planting about the home. It is deserving of more attention in the Midwest.

H. N. A.

ECHINOCEREUS CHISOENSIS

Conspicuous in the deserts of our southwestern states is a group of spiny plants to which the common name, "Hedgehog Cactus," has frequently been applied. These plants are better known to botanists as Echinocereus, a word derived from the Greek meaning "hedgehog-like torch cactus." The name is very appropriate, for the stems are usually very spiny and forbidding, but they also bear lovely radiant blossoms at the top. If you have a vivid imagination the name is certainly not deceiving.

Britton and Rose, those two well known cactologists who published the monumental "Cactaceae" in the early twenties, listed some 60 species of Echinocereus. However, since that time, some have been relegated into synonymy while many others have been discovered through diligent search in the field. For the most part, Echinocerei are erect to prostrate plants ranging from two inches to two feet high. They grow singly or in clusters, a single cluster often forming a massive mound composed of 100 to 150 heads. Their flowers are rather large, bell-shaped or funnelform, and are copiously produced during the spring season. Color of the blossoms ranges from fiery red to regal purple, from ghostly white to golden yellow, and from vivid green to dirty greenish-brown. Out on a sun-scorched desert plain or in the rocky nook of a canyon wall, a mound of hedgehog cactus sprinkled with glowing blossoms is really a sight to behold.

At this time space does not permit an elaborate listing of Echinocerei, but I should like to introduce the reader to an interesting species which hails from the picturesque Big Bend country of western Texas. This one was described as new about five years ago by Mr. William Taylor Marshall, past president of the Cactus and Succulent Society of America. He named it *Echinocereus chisoensis* because it is native to the Chisos Mountains, where it grows usually in full shade, in loose gravelly soil. It is a rather rare species and a difficult one to establish in collections.

This hedgehog cactus of the Chisos produces cylindrical stems up to 5 inches in height, is rather flabby-textured, of a blue-green to purplish green color, while its ribs, 14 to 15 in number, are filled with white to tannish

Echinocereus chisoensis

wool and numerous spines. The radial spines are needle-shaped, unequal, at first chalk-white with dark red-brown tips, later becoming dirty white or retaining their color in subdued tones. The smallest radials always appear in the upper end of the areole while the longest are in the lower end. Two central spines issue from each areole, although 1 to 4 have occasionally been noted; these are blackish with a lighter base, the upper one ascending while the lower one stretches out horizontally. Flowers appear in April but in the greenhouse they may bloom as early as February 20. Blossoms are large and showy, with spreading deep purple to magenta petals. From the center of the floral envelope springs forth a thickened style with bright green stigma lobes. Hugging the style are numerous stamens with pale yellow anthers. The fruit is club-shaped, knobby, and studded with bristles and wool.

L. C.

YOUR QUESTIONS ANSWERED

Hardly a day passes on which the Garden does not receive specimens of trees, shrubs, or flowering plants for identification. Frequently these are so poorly packed that they are badly broken in the mail and determination is either a guess or impossible. Small fragments of leaves, stems, or roots more often than not are worthless or entail more time than our staff members are able to devote to them. When possible obtain a representative specimen bearing a few leaves as well as flowers or fruit (mature seed pods). Press the specimen between blotters or newspaper and pack between stiff cardboard for shipment. Please be sure to include a stamped addressed envelope for reply.

In response to a multitude of calls during the past few weeks: *I have a large sycamore tree in front of my home; the leaves are all turning black. Is the tree going to die?*

The sycamore is affected by anthracnose (one of the sphere fungi, *Gnomonia veneta*). The cool wet weather is ideal for its growth. Sunny, warm days will arrest the fungus disease and new growth will likely follow.

When is the best time to transplant peonies?

During September and October. This will allow some time for re-establishment of the root system before winter. Older clumps should be divided so as to retain at least three or four eyes. When planting set the roots so that the eyes are about two inches below the surface. Aside from their rather short blooming period peonies are among our most satisfactory hardy perennials. They will tolerate some shade but full sun is necessary for best results.

I have an orchid which is bearing a flower sheath and at the same time is producing a new growth. Should I remove the flowering sheath?

No, you evidently have a hybrid which ofttimes produces young growth at the time of flowering.

What is the proper planting procedure for Regal Lily bulbs?

The general rule for hardy bulbs is to plant them as soon after they become dormant as possible. In the vicinity of St. Louis, the proper time to plant Regal Lilies is about the first of October. If you are purchasing the bulbs from out of town, place your order about the first of July. When they arrive don't delay planting, for the longer your bulbs are out of the ground the less are your chances for first-class flowers next spring. Regal Lilies prefer to be planted about 5 inches deep (from the top of the bulb) in a soil composed of about 3 parts good garden soil, 2 parts leaf mould, and 1 part sand. When the soil freezes cover the surface with a loose mulch of straw (to which some branches of the old Christmas tree may be added) to a depth of about 3 inches. This should be left in place until about the first of April.

Is rotenone very poisonous?

Rotenone is a very violent poison to both sucking and chewing insects, and to fishes. Its great advantage lies in the fact that it is not harmful to humans nor to household pets such as the cat or dog. However, like any dust, it may be irritating to some individuals. When applying as a dust be careful not to inhale it.

What should be done with Amaryllis bulbs after they have flowered?

As soon as warm weather is here to stay place the plants outdoors, sinking them up to the top of the pot in the garden. Water them sufficiently through the summer to keep the soil moist. In September bring the plants in, place them on their sides in the cellar, and leave them alone until December. When repotting, use a fertile garden loam to which has been added one teaspoonful of a complete fertilizer per pot. At least one-half of the bulb should be above the soil level. Keep them in a sunny window and water as usual through the flowering season.

When should I transplant Lily-of-the-valley?

Lily-of-the-valley plants become very crowded if left in the same location for more than five years. This crowding does not affect the foliage but the flower stalks become fewer each year. While these plants may be reset at almost any time of the year, September is a good month in which to do the dividing and transplanting. At that time the plants have completed their growth for the season and the soil is usually more moist than during the summer months.

Lily-of-the-valley grows well in the shade. The soil should be reasonably rich and should contain a good deal of humus. The matted plants may be lifted, divided, and planted with only a few pips in each group, the clumps being spaced about a foot apart. The plants should be given a good watering and the soil should never be permitted to dry out while they are becoming established. Top-dress with a light mulch of leaves or old manure in late November.

Please recommend a hedge or shrub that will grow in the shade and form a nice screen.

The Ibolium privet is a good plant for a hedge or screen in the shade. In a few years it will grow to a height of about eight feet. The foliage is a lustrous dark green and the plants remain clothed with leaves to the base. A few other shrubs suitable for hedge or screen plantings in the shade are *Acanthopanax Sieboldianus*, various barberries, American holly, witch-hazel *(Hamamelis virginiana)*, fragrant sumac and several species of Viburnum.

Where should bitter-sweets be planted? How high do they grow?

Bitter-sweet vines may be planted in a sunny or shady location. If grown in full sun the growth is slower but very dense and there will be a heavy set of fruit in the fall; if grown in the shade there is almost no limit to the height a bitter-sweet vine will climb if it has a suitable support. In the woods the best berries are usually high up in the trees.

What is the best type of soil for desert cacti?

The kind of soil best suited for cactus plants is a mixture of well-decomposed leafmold, sand, and ordinary loam in equal parts. Clay is not recommended but if you must use it mix in a generous portion of wood ashes. An addition of crushed lime rubble from old buildings or small chat (such as is used in roadwork as foundation for macadam) is appropriate, for most desert species thrive in limestone regions. When plants are grown in novelty pottery and dish gardens some crushed or powdered charcoal should also be added.

NOTES

One result of the cool rainy weather this spring has been a fine display of roses, particularly the climbers. They have been full of bloom and have stayed in flower unusually long both in the Rose Garden and on the trellis around the Economic Garden.

Groups visiting the Garden during the last month were: students in biology of the Wood River High School, Wood River, Ill., accompanied by their instructor, Mr. W. C. Hopper; students in botany from Washington University, accompanied by Dr. Robert E. Woodson, associate professor, and Mr. Charles B. Heiser, instructor; members of the Ferguson Garden Club, Ferguson, Mo.

Out-of-town visitors coming to inspect the Garden's method of growing orchids include the following: Dr. and Mrs. Luys de Mendonça, of Rio de Janeiro, Brazil, Dr. Mendonça being publisher of the Brazilian orchid journal, *Orquidea;* Mr. K. K. Frazee, of Anderson, Indiana; Mr. William B. Olsen, of Berkeley, Calif.; Dr. A. E. Newland, of Bedford, Ind.; Mr. Young and Mr. Damiata, of A. N. Pierson, Inc., Cromwell, Conn.; Mr. Robert Yohler and Robert Mitchell, of the Stephen Foster Co., Carmel, Ind.

Mr. August P. Beilmann has been appointed chairman of the *Severe Storm Warning Service* in Franklin County. This service, started by the U. S. Weather Bureau, is designed as an aid to military and civilian aviation. Observers posted throughout Franklin County telephone Lambert Field on the approach of a storm, from where the Weather Bureau issues whatever instructions are deemed necessary to planes in flight and those grounded. Should a tornado be reported the possible path is determined and instructions issued to airports, towns in the path, war plants, etc.

Among the recent visitors to the Garden library and herbarium were the following: Lt. (Dr.) H. H. Smith, of the U. S. Naval Reserve, formerly assistant geneticist, U. S. Dept. of Agr.; Dr. Fred A. Barkley, research assistant, Phanerogamic Herbarium, Chicago Museum of Natural History (formerly Field Museum); Mr. Paul A. Allen, field technician, U. S. Rubber Development Corporation, Colombia, S. A.; Capt. (Dr.) George Thomas Johnson, of the U. S. Army, formerly research fellow at the Garden and Guggenheim fellow in Central and South America during 1940-42; Sgt. Richard P. Grossenheider, of the U. S. Army; Dr. Ada Hayden, research assistant professor of botany, Iowa State College, Ames; Rev. Robert R. Brinker, instructor in biology, Quincy College, Quincy, Ill.; Sra. Naranjo de Guzmán, of Bogotá, Colombia, S. A., whose daughter, Miss Julia Guzmán Naranjo, received her Master's degree in botany at the Washington University commencement, June 7.

THE MISSOURI BOTANICAL GARDEN

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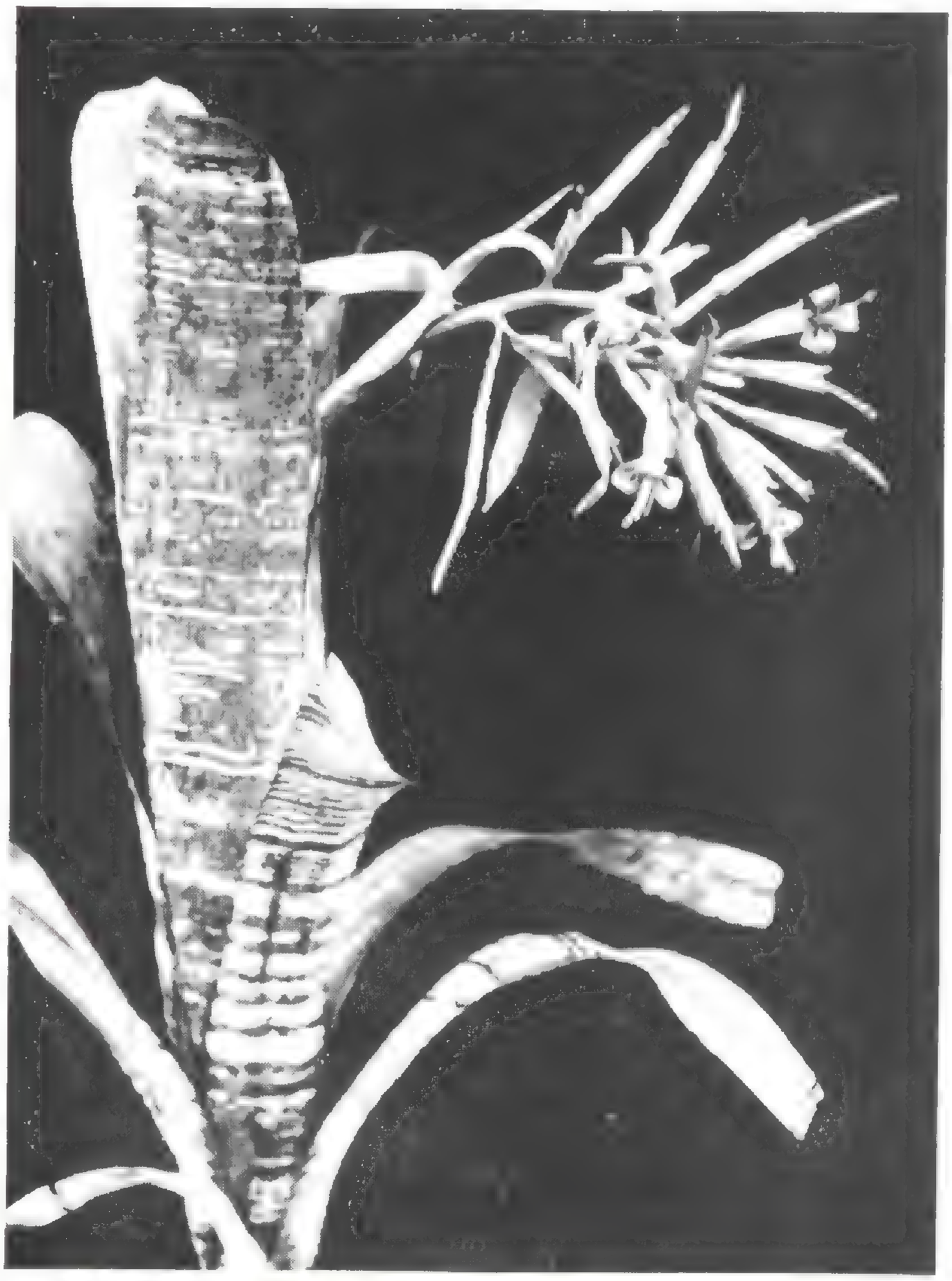
SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

MISSOURI BOTANICAL GARDEN BULLETIN



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BROMELIADS ARE FASCINATING PLANTS

LADISLAUS CUTAK AND GEORGE H. PRING

Aside from two well-known plants, the Spanish moss and the pineapple, very few people are familiar with members of the Bromeliaceae family. However, it comprises more than 1,600 species, scattered among 50 genera, which in gardening circles are frequently referred to as "bromels" or "bromeliads." Like the bizarre Cactus that boasts full American ancestry, so, too, the members of the Bromeliaceae are truly All-American except for one species in the genus Pitcairnia which has recently been reported from Africa.

At one time bromeliads were greatly sought after in Europe, but here in America they have not been so highly esteemed. This oversight might be laid to the woeful lack of English literature on the subject and to the fact that the American nurserymen handle very few kinds. However, in recent years these plants have stirred up much interest among plant fanciers, and there is no doubt that they are beginning to take the place in horticulture which they so deserve.

Members of the Bromeliaceae are classed as tropical or subtropical, even though some of them can withstand a certain amount of freezing weather. Their range extends from southeastern Virginia southward and westward through the coastal states to Texas and across northern Mexico. In the Mexican Republic—in fact in all of Central America—, the West Indies, and adjoining islands they are distributed over the entire land. They are also met with throughout South America, but their areas of thickest concentration occur along the Pacific coast, in southeastern Brazil, and northern Argentina.

The plants are terrestrial (growing in the ground), epiphytic (growing on other plants but not deriving nourishment from them), or saxicolous (growing on rocks). As terrestrials they thrive in the same type of soil as cacti and other xerophytes, covering large dense areas on the desert floor,

or they may prefer the acid soil of a jungle forest where only filtered sunlight is available. As epiphytes they cling to forest trees high up in the air, often beyond the reach of man or foraging animal. Epiphytic bromels should never be considered as parasites for they derive all their sustenance from the air. They rely on the host merely for support, clinging to it with a tenacious grip. The few rock-dwelling bromels attach themselves to precipitous stone outcroppings or grow in the cracks of weather-beaten boulders whose surface is often so hot as to burn one's hand. Growing in such a wide range, under all kinds of conditions, and in various media, it is no wonder that the Bromeliaceae offer some of the most unusual and fascinating plants ever known.

A typical bromeliad plant is formed of a rosette of leaves, either loose or compact, of diminutive or massive size. The leaves may be grass-like or widely strap-shaped, rigid or quite flexible, smooth or rough to the touch, short or elongated, brightly colored or nearly lifeless, often mottled, marbled, striped, or spotted, and with or without marginal spines. The flowering stalk may be terminal or lateral, sunken in the nest of leaves or extending far beyond them. The inflorescence may be a panicle (compound flower cluster) as in Pitcairnia, or a raceme (simple flower cluster) as in Billbergia, capitate (head-like) as in Neoregelia, or strobiliform (pinecone-shaped) as in Ananas. The flowers may be small and inconspicuous or large and showy, lasting a few hours or at most a few days, with or without fragrance. The seed-pod or fruit is often richly colored, and the length of time it remains on the stalk varies with the genus. Most of the bromels possess some sort of a root system although a few of the epiphytic ones, like *Tillandsia usneoides* and *T. decomposita*, have dispensed with this organ altogether and rely on the leaves to perform the function of the roots. The tree- or rock-inhabiting bromels usually have short and stubby roots whose chief purpose is to keep the plants upright or in a position that will serve them best in life. It is often surprising how these short stiff roots can support massive plants on perpendicular surfaces and with what tenacity they cling to tree trunks when the collector tries to dislodge them. The terrestrial bromels usually have a more elaborate meshwork of roots but it is as nothing compared with some of our common perennials.

Some kind of bromeliad can be found in flower all the year round. At the Garden we have photographed flowering specimens in every month, but a greater majority seem to bloom in late winter and early spring and a second wave commences in July and continues up to early winter. As to flowers, the most intriguing pastel shades are found in the genus Billbergia. In shape the flowers are tubular with petals usually spreading widely or

rolling up spirally to the base like a watch-spring. Individual blossoms are short-lived and the whole inflorescence usually completes its blooming cycle within a week. Aechmea flowers are much smaller than those of Billbergia, in some cases nearly microscopic, and although the petals wither shortly after opening the inflorescences remain highly colored for several weeks. This is likewise true of Hohenbergia and of several other genera. Certain species of Tillandsia and of Vriesia are amazingly large and beautiful and are much sought-after plants, particularly those possessing a distichous

Vriesia splendens

A hybrid Vriesia (x *Mariae*)

(arranged in two vertical rows) or fan-shaped inflorescence. Dyckia is another genus popular with cactus fans. In Neoregelia the flowers are congregated in a dense flattish head resembling a shaving-brush and sunk in the center of a nest-like rosette of leaves. The white or lavender flowers of Nidularium are in a dense head issuing from the center of the leaf rosette, but whitish flowers also spring forth in the axils of the surrounding reduced leaves. In Cryptanthus the white flowers are bunched in a small tuft in the center of the rosette. The above genera represent those most frequently met with in American collections.

HISTORY

The discovery of the first bromel was coincident with the exploration of America by the Spaniards in 1493. It was then that the companions of Columbus first saw the pineapple on Guadeloupe Island in the Lesser

Antilles. The flavor and fragrance of the fruit astonished and delighted them, according to the chronicler, Peter Martyr de Anghiera. All the early historians, Las Casas, Oviedo, Benzoni, etc., mention the pineapple in their books. Oviedo, who came to America in 1513 and remained several years to gather knowledge about Spain's new kingdom, describes three kinds of pineapples in his "Historia General de las Indias." This precious old tome, published in 1535, contains what is believed to be the first accurate illustration of the fruit.

Pineapple *(Ananas comosus)*

No one knows just where the pineapple originated. However, it is presumed that it grew in Brazil or even in the Guianas whence it was introduced by the Carib Indians to the West Indies long before the white man first set foot in the New World. Nor do we know for how many centuries the plant had been cultivated in tropical America, but it must have been from time immemorial judging from the fact that it would have taken years for the Indian agriculturists to develop the wild hard fruit into the luscious product that it was when the Spaniards arrived. The native varieties were further improved by the early American colonists until today the pineapple is one of the choicest of tropical fruits.

It is presumed that the Spaniards lost no time in introducing the pineapple *(Ananas comosus)* to the Philippines and the East Indies, whence it found its way to China and India. One writer claims that the fruit was

common in India as early as 1549. Another stated that it had been naturalized in Java as early as 1599. The plant was brought to Europe about the middle of the seventeenth century and successfully fruited in Holland in 1686. Four years later plants were sent to England but it was not until 1712 that they were fruited by Sir Mathew Decker in his garden at Richmond in Surrey. At first the pineapples were seen only in greenhouses where they were raised for rich landowners but later they were imported and became a common sight in English markets. The pineapple to-day is being cultivated in all the tropical lands of the world, and many million fruits are consumed annually, either eaten raw or used in jams, confections, beverages, etc.

Tillandsia usneoides, better known as Spanish moss, was most likely the second Bromeliaceous plant seen by the early Spanish explorers. It is doubtful, however, if they realized that it was so closely related to their delicious

Spanish moss *(Tillandsia usneoides)*

pineapple. Composed of fine long threads which are covered with silver-gray scales, the Spanish moss looks more like a lichen than a bromel. But then should you examine the plant closely the inconspicuous greenish flowers issuing from the transformed leaves would betray its identity. It is the most widely dispersed bromel in existence. Its northern limit is the Dismal Swamp in Virginia, while its southern limits extend to Argentina, thence across to Chile and up the Pacific Coast to Lower California. It is never found very far inland and wherever it grows it imparts a ghostly atmosphere. Tangled garlands of Spanish moss festoon live oaks and cypress trees along the streams and bayous of southern and southeastern United States and transform the landscapes into veritable fairylands.

This strangely weird moss has an economic importance. The natives of the southern United States pull it down from the trees with hooked poles and rakes and sell it as stuffing for furniture and mattresses. It is the fine hair-like thread in the stem and leaves which is desired. An energetic picker can gather from 200 to 300 pounds a day but it must be cured before it can be used. In the early days the moss was buried to hasten disintegration but now it is immersed in the bayous for several days and then spread along fences and racks to be cured by the sun and rain. Before World War II cured moss, bailed, brought the moss picker about two dollars for each hundred pounds, which seems like a paltry sum but it suffices for the swamp-dweller's needs.

From the time Columbus first saw the pineapple to the days of Linnaeus (a lapse of 260 years) only a few kinds of bromels were known. In his "Species Plantarum" (1753), Linnaeus, the Swedish botanist who is considered the father of modern botany, recognized two genera of Bromeliaceae: Bromelia, to which he assigned five species, and Tillandsia which contained nine. These fourteen bromels are now called *Ananas comosus*, *Aechmea nudicaulis*, *Ae. serrata*, *Bromelia Karatas*, *B. Pinguin*, *Guzmania lingulata*, *G. monostachya*, *Tillandsia polystachia*, *T. recurvata*, *T. tenuifolia*, *T. utriculata*, *T. usneoides*, *Vriesia paniculata*, and *Wittmackia lingulata*. During the next hundred years the number of bromels had increased to such an extent that about 350 species, belonging to 27 genera, were recognized by Bentham and Hooker in their "Genera Plantarum", published in 1862-1883.

In the middle part of the nineteenth century some important plant discoveries were made in Mexico and Central America as well as in countries of South America. It is true that many of these explorers went in search of orchids but they did not overlook other promising horticultural material. Some of the best-known collectors of the Bromeliaceae of that time were: Karwinski, Andrieux, Bourgeau, Schiede, Skinner, Leibold, and Gaudichaud, all of whom collected in Mexico and Central America; and Blanchet, Ule,

Group of ornamental bromeliads

Bromeliad Propagating House

Glaziou, Tweedie, Miers and Poeppig, who confined themselves to Brazil and other South American countries. The names of most of these collectors are now commemorated in plants. William Friedrich von Karwinski, a Bavarian naturalist, after having collected in Brazil, was sent in 1826 to hunt objects of natural history in Mexico. He remained there about five years, then went back in 1840 for three years more. During those eight years he sent home a great number of living plants. Andrieux, another collector of Mexican bromeliads, made his collections before 1835. Bourgeau, working for the French Scientific Commission to Mexico in 1865-66, is said to have made a more thorough search of the districts traversed than any other collector in Mexico. Glaziou was probably the greatest collector of Brazilian bromeliads and is honored in the genus Neoglazovia, plants of which furnish good fiber for ropes.

From about 1850 to 1890 an intense interest developed in the Bromeliaceae, particularly in France, Belgium, and Holland. Prof. Edouard Morren, of Liège, Belgium, was regarded as the greatest authority on this group of plants, and he also did more to popularize them than any other bromel enthusiast. He had the most complete living collection of bromels at that time, which after his death, in 1886, was purchased by the Kew Gardens in London. For twenty years he was busy accumulating notes, drawings, and observations on this fascinating plant family. He was editor of *La Belgique Horticole* where most of his notes on bromels were published. Sharing his enthusiasm for these plants were other editors of that era: Eduard Regel and L. Wittmack of *Gartenflora,* whose names are honored in the genera Neoregelia and Wittmackia; E. A. Carrière of *Revue Horticole*; Charles Lemaire, Edward André, and J. Linden, of *L'Illustration Horticole*. In 1889 J. G. Baker published a "Handbook of the Bromeliaceae," the first extensive English work on this subject, in which he described over 800 species.

At the present time more than 1,600 species and varieties of Bromeliaceae are listed, and many more will probably be discovered as botanical searchers push deeper into American jungles or as keen observers detect differences in plants already known. The Bromeliaceae contain a number of species, particularly in the genus Vriesia, which look so alike that it is difficult to distinguish them when not in flower. Sometimes a new species turns up from regions that have been well combed over, due mostly to the fact that plant hunters overlooked the specimens in flowerless seasons.

The most noted collector of bromels at present is Mulford B. Foster, of Orlando, Florida. Prior to World War II he made two 6-months trips to Brazil and brought back many long-lost species as well as some 80 new things. The latter have already been described by Dr. Lyman B. Smith, of

the Gray Herbarium, the present authority on this plant family. It is probable that many more new species, or at least varieties, will result from Foster's collecting. In his Orlando Orchidario Foster has been hybridizing many of his new introductions and already has developed some spectacular specimens which will be on the market as soon as enough stock is propagated. The Garden is the recipient of many of Foster's new plants, and he claims that we have the largest number of Bromeliaceae of any botanical institution in the United States. More than 160 species, including a large number of rarities (excluding the hybrids), are represented in our collection. Of the 50 genera recognized all but 17 are included. It may be of interest to list the genera represented at the Garden, with the number of species of each genus.

Acanthostachys 1
Aechmea 25
Ananas 4
Androlepis 1
Araeococcus 1
Billbergia 19
Bromelia 2
Canistrum 2
Catopsis 1
Cryptanthus 8
Deuterocohnia 1
Dyckia 12
Encholirium 1
Fascicularia 1
Gravisia 1
Greigia 1
Guzmania 3
Hechtia 2
Hohenbergia 3
Lindmania 1
Neoglaziovia 1
Neoregelia 11
Nidularium 7
Orthophytum 1
Pitcairnia 10
Portea 1
Pseudananas 1
Puya 4
Quesnelia 5
Streptocalyx 1
Tillandsia 21
Vriesia 9
Wittmackia 1

CULTURE

Bromels are amongst the easiest plants to grow in the greenhouse and also make very good house plants. The spiny desert kinds can be grown like cacti and are often included in cactus collections. Some of the dwarf varieties such as Dyckias and Cryptanthi do well in dish gardens. Those bromels that spend their natural life on tree trunks and branches often keep company with orchids, aroids, and other epiphytes and will require the same treatment as given those plants. Many home gardeners consider these epiphytic bromels more suitable as house plants than the desert kinds because they do not possess the vicious spiny armament of the latter.

The epiphytic bromels are well supplied with moisture in their native habitats, even in the dry season. This is because the gutter-like leaves which form the rosette growth direct the rain or moisture to a natural reservoir in the center. It is not uncommon to find plants holding a gallon of water, hence the common name "tank air plant." In the greenhouse Nature's system of watering should be adopted, that is, the rosette "vase" should be filled. However, as it holds water only up to the imbricated base of the leaves the overflow reaches the roots. In their natural habitats the rosette is the chief means of water intake and the roots serve to support and fasten the plant to the bark of the tree. *Tillandsia recurvata* and *T.*

usneoides have been observed growing upon trolley wires in the tropics. Most bromels do not like "wet feet," and if planted in too large a pot root deterioration and subsequent discoloration of the leaf results.

During the summer it is necessary to shade the roof of the greenhouse so as to permit 25–30 per cent light. A few of the highly colored species prefer more shade. Atmospheric conditions should be humid with a winter temperature of from 65 to 70° F. Extreme heat with dry temperature will cause burning of leaves as was experienced at the Garden in 1936 (see Mo. Bot. Gard. Bulletin **24**:179. Sept. 1936).

The best potting material for epiphytic bromels is fibrous peat, but since the scarcity of this substance we have been using, with good results, the discarded orchid peat. Like the orchids, these plants prefer firm potting. This may be accomplished by wedging small clumps of peat sideways into the pot, using a pointed potting stick as a fulcrum to cause the lateral pressure. Do not try to insert the peat from the top as that will create an upward pressure, resulting in a loosely potted plant. If the material is moistened it works much better. When transplanting avoid breaking the fine black roots which look like peat. A single potting is sufficient to carry the plant through to the flowering period.

The habit of growth is usually sympodial (axial growth continued by successive lateral shoots). When growth is completed the flower spike

Bromel offshoot ripe for propagation

appears from the base of the leafy rosette. With the ripening of the seed-pods the life cycle of that shoot is complete, no further leaves developing from the rosette. The shoot, however, produces suckers from its base for which it provides food and water. In propagation these young shoots are removed when about 2 or 3 inches high, being cut close to the old base, and then rooted in equal parts of sand and sphagnum moss. The old plant will then make new suckers. If the grower wants only a few plants then leave the shoot until well enough rooted so that only a single potting is necessary. Plants of the genus Cryptanthus, frequently used in dish gardens, produce several growths from the old flower spike. These will voluntarily drop off, at which time they are easily rooted in sand. The common pineapple is another example of this viviparous habit (sprouting while still attached to the parent plant).

Most of the bromels produce plenty of seeds. Those of Billbergia when ripe are stuck together within the pod by a gelatinous substance which attracts both ants and mice. If this is not washed off the seed-pan may look like a fox-hole. The desert species such as Dyckias should be sown like cactus seed in a soil mixture of well-rotted leaf-mold, sand, and garden loam. Firm the soil gently and barely cover the evenly distributed seeds with sand. Do not water from above but place the seed pan in a shallow pan of water (feeding by capillary action). The water also acts as a partial barrier against ants. Finally place a piece of glass over the top of the pan to prevent change of temperature and rapid drying of the surface. When the seedlings are large enough to handle conveniently transplant them into community pans, then into single pots. Tillandsia seeds are very minute and have cottony appendages. They should be sown as soon as ripe since they soon lose their ability to germinate. Sow them on the surface of finely chopped sphagnum moss. The use of a Wardian case will give the best results in germination. It should be maintained at a temperature of 70° F., which is an ideal temperature for germinating all bromels.

Generally speaking, insects are not a problem with bromels. The soft seedling leaves are sometimes attacked by thrips, but these may be controlled by a rotenone or nicotine spray. Adult plants occasionally will become infested with a minute black hard-shelled scale which is hard to eliminate. Spraying with miscible oil is dangerous since the spray will reach the central leaf reservoir, then flow over the leaves to the roots. If used be sure to tip the plants to dump out all water and oil film. A positive remedy is to segregate the plants, remove all water from the center, dry them for a day, then fumigate with cyanogas. Where the grower has only a few plants the slow method may be adopted of brushing the scale with the miscible oil solution.

To help the beginner to become acquainted with this fascinating group of plants we select a number of species for their outstandingly beautiful foliage and for their brilliancy of bloom.

BEAUTIFUL FOLIAGE

Aechmea caudata variegata
fasciata
Fosteriana
fulgens discolor
miniata discolor
orlandiana
Pineliana
Billbergia horrida tigrina
Meyeri
Saundersii
vittata
zebrina
Cryptanthus Beuckeri
zonatus
Guzmania musaica
Neoglaziovia variegata
Neoregelia marmorata
sarmentosa chlorosticta
spectabilis
Nidularium amazonicum
fulgens
procerum
Innocentii lineatum
Innocentii striatum
Tillandsia Butzii
streptophylla
Vriesia Fosteriana
guttata
hieroglyphica
Saundersii
splendens

BRILLIANT FLOWERS

Aechmea distichantha
fasciata
Mertensii
Racinae
Weilbachii
Billbergia Euphemiae
pyramidalis
thyrsoidea
Quesnelia Liboniana
Tillandsia Lindeni
Lindeniana
Vriesia carinata
X Mariae
psittacina
splendens

DESCRIPTIONS

The interesting bromeliads that have flowered in the Garden's collection are described in the following paragraphs:

Acanthostachys strobilacea is a rather straggly plant with several spreading and slender, few-leaved stems. It is a botanical oddity at most, hardly fit for home culture or even a small greenhouse, but it does produce a rather interesting and colorful inflorescence of Light Yellow Green* flowers and Carrot Red to Carnelian Red bracts. First introduced in 1840.

The genus *Aechmea* is composed of about 150 species, most of them growing high up on gigantic trees. Some of them are unusually stunning with long-lasting flower-heads, but the individual flowers are generally small.

Aechmea bracteata is a robust grower which thrives exceedingly well in the soil of our Palm House. Grown as a pot plant its erect rigid leaves form a tight, cylindrical, vase-like container but when planted out in the ground the plants form huge clumps with spreading leaves 5 feet or more in length. The leaves are bright green and armed with large, vicious, widely-set, marginal teeth. The flower-stalk is at least 3 feet high and bears at the top a slender pyramidal, branched inflorescence with tiny Pale

* Technical color terms used are those of Ridgway, Color Standards and Color Nomenclature.

Greenish Yellow flowers. The bright red to Rose Red scape bracts, which are the conspicuous feature of the flower-head, remain beautiful for at least eight weeks. Grows in Mexico and Central America.

Aechmea bromeliifolia is a medium-sized plant with flexible Lettuce Green leaves covered underneath with minute, closely set, silvery-white scaly lines. The flower-stalk rises above the spreading foliage and bears an oblong, densely white-woolly, pinecone-shaped spike, with the flowers arranged in 8 slightly spiral rows, 5 to 9 to a row. The individual flowers are embedded in the wool of the spike, only the petals and a small portion of the calyx protruding from it. The petals are Straw Yellow, but soon turn black. Grows wild in northern South America.

Aechmea Fosteriana

Aechmea fasciata

Aechmea distichantha is another robust grower from Brazil. The broad inner grayish leaves form a vase about 2 feet high, but when grown in the ground they have a tendency to spread out and become narrow and elongated. The inflorescence is a dark pinkish, densely white-woolly panicle with crowded, claw-like branchlets upon which the Amethyst Violet flowers rest.

Aechmea fasciata, one of the most fascinating of all Aechmeas, was first introduced into cultivation from Brazil in 1826. Picture a foot-high marbled greenish vase from which issues a bouquet of pink and bluish flowers and you have a mental image of this superb specimen.

Aechmea fulgens discolor is a common and very attractive plant from French Guiana. Some 15 broadly strap-shaped leaves form a vase-like

rosette from the center of which emerges a foot-long Carmine stalk bearing an equally colorful triangular panicle of flowers. The petals are Mulberry Purple, thick, boat-shaped, opening slightly in late afternoon and turning Rose Red on withering. The calyx, with the adherent ovary, forms a rich Scarlet Red berry which remains brilliant for at least two or three months.

Aechmea Mertensii is a rare bromel from Brazil and the Guianas. Its bright green, scaly leaves are beset with spreading spinous dark brown teeth all along their margins. The 8- to 12-inch flower-stalk is covered with conspicuous Jasper Red bracts and topped by a dense cylindrical spike composed of numerous flower clusters, 5 or 6 flowers to a cluster. The sepals are Light Orange-Yellow tinged faintly with red and terminated by a prominent blackish rigid spine. Petals are deep red and the berries, upon maturing, turn a Deep Chicory Blue.

Aechmea miniata discolor is a very decorative plant, its beautiful foliage being Violet Carmine beneath and a soft lustrous green above. The somewhat dense flower-head is Nopal Red to Carmine in color and bears tiny lilac sessile flowers on the branchlets. The berries are flesh-colored at first, bright cherry-red at maturity.

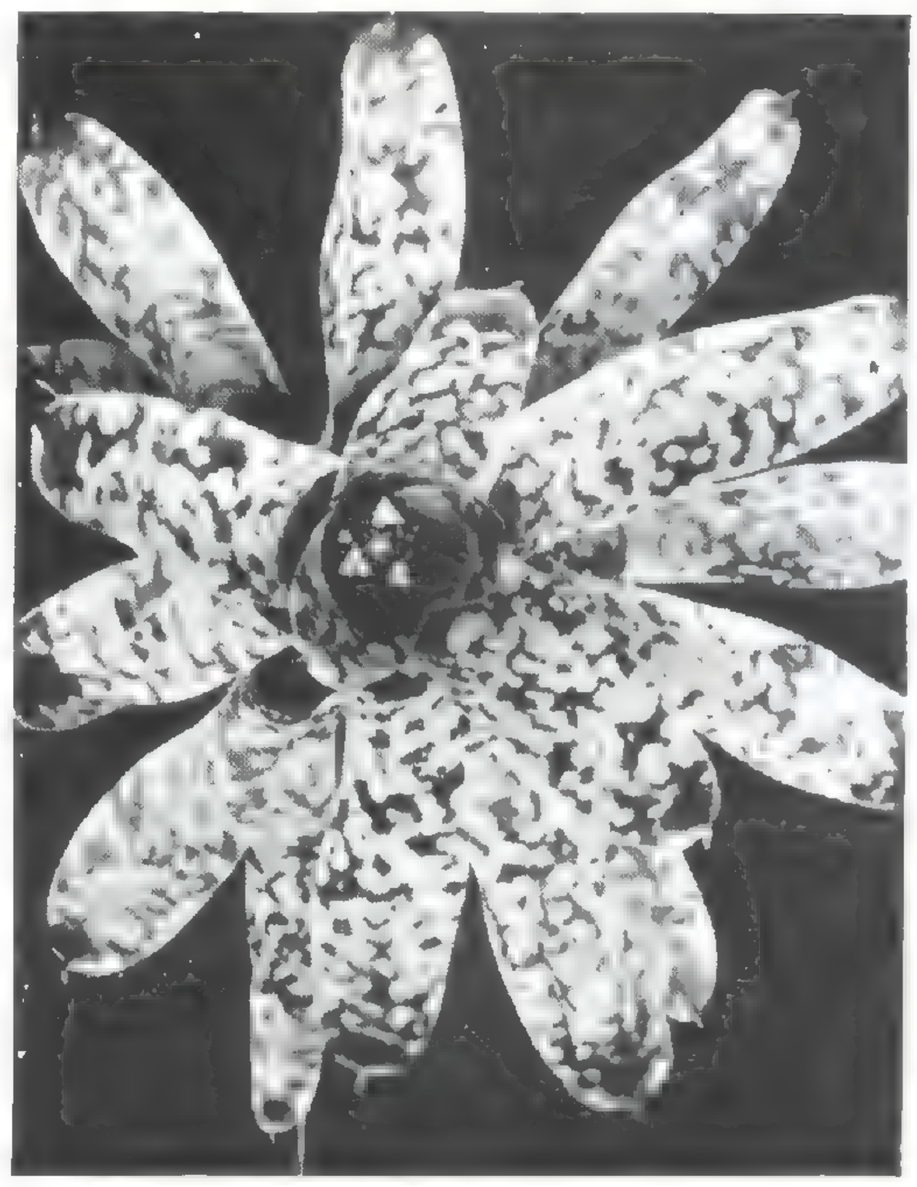
Aechmea pubescens is a Central American species with none of the brilliancy of those mentioned above. Contains no merit at all.

Aechmea Racinae is a Brazilian species discovered by Mulford Foster only a few years ago and named for his wife, who accompanied him on his two bromel hunts. This species is different from all the others in the genus in having a most startling pendent inflorescence with individual flowers bright red, pale yellow-chrome and black, reminding one of the "corn candy" sold in confectionery stores. To display the flowers to best advantage the plant should be grown in a hanging basket or else attached to a bark slab as is done with orchids.

Aechmea recurvata is a stiff, Yellow-Green plant from Uruguay whose inner leaves commence to turn red when the specimen is about to bloom. The marginal prickles are small, chocolate-tipped, and quite sharp. The purple flowers appear on a dense erect spike, but are hardly noticeable because the tightly clasping leaves partially hide them.

Aechmea victoriana is another Foster introduction from Brazil. There happen to be two forms of this, the red and the green. The leaves of the red form are richly tinged underneath with reddish-purple, while the flower-stalk is dull reddish and the scape bracts black. The green form, on the other hand, has bright green leaves, flower-stalk and bracts. The species has a strange flower, the petals being Raisin Purple and the ovary peach-colored slightly tinged with Scarlet-Red.

Flower cluster of *Billbergia thyrsoidea* (Flaming Torch Plant)



Neoregelia marmorata

Nidularium Innocentii var. *striatum*

Nidularium Innocentii var. *lineatum*

Aechmea Weilbachii is a striking stemless bromel with Oil Green to bronze-red leaves and a bright floral stalk supporting lilac-colored blossoms. It is a very good grower and easy propagator. Hails from Brazil, home of many fine bromels.

Ananas comosus (the well-known pineapple) makes an interesting house plant which any one can grow. The crowns from the pineapples that you buy can be cut off, calloused and planted. There are several varieties or forms cultivated. The rigid flower-stalk bears a pinecone-like inflorescence with violet or purplish flowers.

Androlepis Skinneri is a rare Guatemalan plant that somewhat resembles *Aechmea mexicana* in its vegetative characters, but the inflorescence is different. Its leaves are wide with serrate edges and form a nestlike rosette. They are usually Brick Red to purple-red on the upper surface, particularly when about to bloom.

The genus *Billbergia* boasts of having a great array of showy members, not merely for the flowers but for the whole inflorescence including the attendant bracts and foliage. The flowers, however, are short-lived and turn brown immediately after blooming. *B. amoena* is a species with so many variations that it makes your head spin. In our specimens the leaves are rather soft-textured and the flowers are light green flushed Dark Bluish Violet at the petal tips. The pinkish bracts are a conspicuous part of the flower-stalk.

Billbergia Euphemiae is a Brazilian bromeliad with exquisite drooping delicate Salmon Color and deep violet flowers. Its name commemorates the wife of Prof. Morren, who first flowered the plant at Liège, Belgium, in 1868.

Billbergia macrocalyx is a long tubular plant with bright green, pale-spotted and white-banded leaves and a densely white-mealy spike bearing several pale greenish flowers with Light Violet-Blue tips.

Billbergia macrolepis is a slim tubular Panamanian plant which is said to resemble the Brazilian *B. Meyeri* in vegetative characters, but as we have not as yet flowered the latter species we cannot compare them. When Mr. Pring collected our plants in Panama, fifteen years ago, he thought that they might be slender forms of the beautiful *B. zebrina*. They may yet turn out to be something new as the floral bracts are not as long as those on the type sheet of *B. macrolepis* in the Garden herbarium.

Billbergia nutans is one of the commonest species in this genus, but it is by no means one of the handsomest. Its leaves often are grass-like and from the tufted rosettes spring forth drooping spikes of oddly colored green flowers with a distinct dark Aniline-blue margin.

Billbergia pallidiflora is a Mexican species belonging to that group whose

petals roll up like a watch-spring. This one, however, is the least showy of the group and has pale green flowers as the specific name suggests.

Billbergia Porteana is one of the showiest tubular bromeliads. The very firm, erect leaves are marked by irregular transverse bands of mealy white pubescence. The flower-stalk bears a drooping spike of satiny green flowers with long exserted greenish to violet stamens. Its petals roll up spirally from the apex to the base.

Billbergia pyramidalis is an old-fashioned favorite found in most collections. Its flowers appear in a dense spike and are Rose Red with violet tips.

Billbergia Saundersii is a highly colorful species both as to foliage and flowers. The leaves are thickly spotted with white, pink and pale yellow, while the flowers are deep green with Roslyn Blue in the upper portion.

Billbergia thyrsoidea is a bright green stoloniferous species that sends up a dense torch-like inflorescence of bright scarlet flowers tinged Violet-Purple at the tips. Although epiphytic this member thrives well on the jungle floor of the Palm House and lights up, literally speaking, darkened nooks when in blossom.

Billbergia zebrina is a highly prized ornamental from Brazil. The leaves are mostly Dark Livid Brown with light greenish or pale yellow blotches and gray bands. Inflorescence is a drooping spike with satiny green flowers and greatly revolute petals.

Although Cryptanthus is a Brazilian genus it may possibly be found also

Cryptanthus zonatus

in the Guianas. The genus contains about 12 species, the most popular of which is *C. zonatus*, a short, stemless, rosette plant. The leaves are marked with wavy cross-bands of dirty white scales suggestive of zebra stripes. The flowers of the Cryptanthi are white and appear freely. *C. bahiensis* is a new desert species discovered by Foster, with wavy, spiny leaf margins and glabrous, light green foliage.

The genus Dyckia contains more than 75 species most of which are Brazilian although several are also found in Argentina, Paraguay, Uruguay, and Bolivia. The majority are desert terrestrials of dwarf or large size, with very thick and rigid, spine-margined leaves arranged in dense, compact or loose rosettes. The flowers are small, somewhat bell-shaped, and bright yellow to orange. Cactus fanciers are most enthusiastic about the Dyckias and justly so. The common species are *D. rariflora*, *D. sulphurea*, and *D. remotiflora*.

The genus Guzmania contains over 80 species of mostly epiphytic herbs growing wild in Central America, the West Indies, and northern South America. One of the oddest and best known is the Colombian *G. musaica* whose purple-tinted green leaves are peculiarly marked with fine wavy lines of red-brown. The stemless or slightly caulescent *G. Zahnii* produces a loose rosette nearly 3 feet broad. Its leaves are green tinged with red throughout and have pronounced dark red longitudinal stripes at their base. The flowers are yellow. The discoverer of this plant, Mr. Zahn, collector for the nursery firm of Messrs. Veitch of London, was drowned on one of his collecting trips in Panama.

The genus Hohenbergia is confined to South America and the West Indies. Some 30 species are recognized, the best known being the Brazilian *H. stellata*, an Aechmea-like plant with rigid spinescent foliage and a branched inflorescence of reddish bracts and Violet-Purple flowers.

Lindmania contains about a dozen species of low, slender, terrestrial herbs. The best known is *L. penduliflora* but it cannot be classed as an ornamental in any way. The flowers are small, whitish, and pendulous on wiry, semi-horizontal branchlets of the 2-foot flower stalk.

In Neoregelia are to be found some of the most outstanding members of the Bromeliaceae. The genus is confined mostly to Brazil. *N. ampullacea* is a very distinct slender plant with lightly marbled leaves and violet flowers.

Neoregelia Carolinae forms a large spreading rosette of Calla Green leaves, the inner circle of which assumes a brilliant Pomegranate Purple color when the plant is about to bloom. The low flower-spike puts forth Violet-Blue blossoms. *Neoregelia laevis* has wider leaves than the preceding but they are not as vivid although flushed pink at the base and along the margins. The flowers are white.

Neoregelia marmorata should be included in every collection of house plants. Its green leaves are heavily blotched with Violet Carmine on both surfaces. The dense flower cluster consists of from 55 to 70 flowers but only 3 or 4 open at a time, which seems to be characteristic of the genus. The flowers are white, greenish at the center and light lavender at the tips.

Neoregelia Pineliana is a rare species with linear-lanceolate, Brownish Vinaceous leaves arranged in a somewhat interrupted rosette. The head of violet flowers is surrounded by brilliantly colored bract leaves of Rosolane Purple.

Neoregelia spectabilis is readily recognized by the singular bright Aster Purple patch, a half inch deep, at each leaf. It reminds one of a lady's painted finger-nail, and is now popularly called "finger-nail plant." Beauty shops and barber shops should feature this plant in their show cases.

Neoregelia tristis is another plant worthy of cultivation. Its narrow leaves are bright green with blotches of red-brown. A somewhat loose and dwarf replica of the more spectacular *N. marmorata.*

The genus Nidularium is characterized by nest-like rosettes, the generic name being derived from the Latin *nidus* meaning "nest." There are about 30 species, all native to Brazil. One of the most outstanding variegated species is *N. Innocentii* var. *striatum.* Its rosettes are composed of 50 or more stiffish Lettuce Green leaves vertically striped with unequal lines of Chartreuse Yellow. The inner cluster of foliage turns red at the tips when the flower spike makes its appearance. *N. Innocentii* var. *lineatum*, with finer alternate green and white lines, is much rarer in collections. Flowers are white.

Pitcairnia contains mostly plants that thrive on rocky bluffs, in rock crevices, or in the ground. Over 180 species are described, one of which, *P. Raimondii*, is probably the largest and most striking member of the Bromeliaceae. J. Francis Macbride states that it is used for roof timbers. *P. Andreana* is remarkable in the genus for its dwarf habit and simple close raceme of very large, scarlet and rich yellow flowers.

Pitcairnia corallina is a distinctly decorative species with leaves much resembling those of the weevil plant, *Curculigo recurvata.* The remarkable bright red flower stalk arises from the base of the tuft of leaves, then abruptly curves downward, causing the raceme of bright red flowers to lie on the ground.

Pitcairnia latifolia is a densely tufted, grass-like plant from the West Indies, with a simple or few-branched inflorescence of reddish flowers.

Pitcairnia xanthocalyx is a dense terrestrial composed of narrow flexible Pea Green leaves and a simple inflorescence of Light Viridine Yellow flowers.

Quesnelia Liboniana, discovered by the adventurous naturalist, Libon, in

Tillandsia Lindeniana (Fan flower)

Tillandsia streptophylla

Tillandsia ionantha

Tillandsia anceps

the forests of Brazil about 1848, is a showy deep green bromeliad with highly colorful flowers. The individual flowers are sessile, 2½ inches long, with a Coral Red to scarlet ovary and calyx and Dark Bluish Violet flowers.

The genus Tillandsia consists of nearly 400 tropical and subtropical species of various habits. It is the most widely scattered genus in the Bromeliaceae. *T. anceps* is a stemless, grass-like species with an ovate-elliptic flower spike composed of closely imbricated white to greenish flower bracts. The Pale Mauve to Lavender-Violet flowers are rather poor and inconspicuous as compared with *T. Lindeni* and its relatives.

Tillandsia Baileyi is a south Texas species with leaves involute or rolled inward, finely ash-scaly all over. The inflorescence is a simple spike bearing about six mauve to violet flowers.

Tillandsia Balbisiana is a Florida native whose long inflated leaf sheaths form a characteristic ovoid pseudobulb 2-4 inches high. The inflorescence is typical of most Tillandsias and the flowers are Manganese Violet.

Tillandsia bulbosa is a botanical oddity. Like the preceding, its leaf sheaths form a dense ovoid pseudobulb but hard and inflated, green outlined with red. The blades are rigid, waved, and somewhat spirally twisted.

Tillandsia Butzii resembles *T. bulbosa*, but the smaller inflated pseudo-bulb, as well as the leaf blades and flower stalk, is Olive Green with purplish confluent spots. The coloring makes the plant more attractive.

Tillandsia ionantha is a saucy, dwarfish, tufted epiphyte, only 3 to 4 inches high. Its numerous stout leaves are covered with coarse spreading scales, making it look as if coated with sugar. The Haematoxylon Violet tubular flowers are few and half concealed in the tuft of silvery leaves. Highly desirable for any collection.

Tillandsia juncea is a rush-like plant with firm, dark green, filiform leaves in dense rosettes 1 foot high.

Tillandsia Leiboldiana belongs to the broad-leaved group. However, this not being one of the showy kinds, is ruled out as an ornamental.

Tillandsia Lindeni and *T. Lindeniana* are without a doubt the showiest members of the *Bromeliaceae* and the most sought-after botanical oddities. Both are composed of many gracefully recurving leaves but the inflorescences and flowers easily separate them. *T. Lindeni* has an elliptical to fan-shaped flower-spike Amaranth Pink in color, and the flowers are Amethyst Violet. *T. Lindeniana* grows a longer flowering stalk and its inflorescence is more oblong-lanceolate, perhaps tinged with more Rose Pink, and the flowers are slightly larger with definite white eyes.

Tillandsia Schiedeana is a distinctly caulescent species with straggly silver-green leaves and a short dense spike of Lemon Chrome flowers.

Tillandsia streptophylla is a most curious and beautiful Mexican brome-

liad with a dense pseudobulb and twisting leaf-blades and red-tinted, imbricated, bract-like leaves—nearly hiding the purple flowers.

Tillandsia tenuifolia is another rush-like bromel growing in graceful tufts. Produces typical tubular violet flowers and hails from Florida.

Tillandsia usneoides is one of the most curious plants of the whole family. It hangs from trees in bunches many feet long, which habit is responsible for its variety of common names, as Spanish Moss, Long Moss, Santa Claus' Whiskers, etc. The inflorescence is reduced to one pseudo-terminal green flower which is hardly noticeable.

The genus Vriesia is very close to Tillandsia, differing from it chiefly in its appendaged petals. Many of the species are brilliant-flowered, somewhat reminiscent of the bright plumage of the parrot. Others possess less spectacular flower-stalks, but their crowning glory is the leaves.

Vriesia hieroglyphica is one of the most stunning of foliage plants. It has a decided protective coloration in its zigzag mottling, and, when viewed high on a branch with the sun shining through presents an inspiring sight.

Vriesia scalaris produces medium-sized bright green rosettes from which extend foot-long red flower-stalks studded with long, tubular, green-tipped yellow blossoms, each one partially enclosed in a convolute Rose Red to Opal Red bract.

Vriesia splendens is an outstanding foliage plant first introduced into cultivation about 1840. The broad green leaves are marked with very distinct, broad, wavy cross-bands of purplish black, more pronounced beneath. The foot-long, green floral-stalk is covered with clasping, striped bract leaves. The inflorescence is a compact lanceolate spike composed of imbricating bright red bracts from which issues a yellow flower. The plant comes from French Guiana, the country of the famous French penal colony at Devils Island. It seems somewhat ironic that the most bizarre bromel mimics a convict's garb so well.

Vriesia X *Mariae* is a beautiful hybrid with a broadly ovate inflorescence on a long peduncle, its Carmine, green and yellow floral bracts tightly compressed to form a spike as in *T. Lindeni.* Flowers are Wax Yellow tipped green. This should be a "must" on your list.

NOTES

The Greater St. Louis Victory Garden Harvest Show, sponsored by the Victory Garden Council, will be held in the Floral Display House at the Garden on September 15 and 16. The Show is for non-commercial amateurs, and all exhibits must be grown by the exhibitor, a person who does not sell plants, fruits, or vegetables for profit and who is not employed as a gardener. Prizes of $1,000 in war stamps and bonds will be awarded. In addition, the General MacArthur Medal will be awarded to the junior exhibitor having the highest number of points. For a schedule of exhibits and application blank or for further information call or visit the St. Louis Victory Garden Center, 4th floor Civil Courts Building, Phone 5280, Station 372.

Visitors to the Garden during the summer months include the following: Dr. George J. Goodman, Professor of Botany, University of Oklahoma, Norman; Dr. Harry J. Fuller, Professor of Botany, University of Illinois, Urbana; Dr. Ernst Abbe, Professor of Botany, University of Minnesota, Minneapolis; Dr. Carl O. Sauer, Chairman Department of Geography, University of California, Berkeley; Dr. Mary Maxine Larisey, Chairman Division of Science, Judson College, Marion, Ala.; Dr. Francis E. Drouet, Curator of Cryptogamic Botany, and Mr. Donald Richards, of the Chicago Natural History Museum (Field Museum); Mrs. Walter Hendrix Hodge, of Medellin, Colombia; Dr. A. H. Musick, Associate Professor of Pharmacology of the University of Tennessee, Memphis; Sr. Cooracy M. Franco, of the Instituto Agronomico, Campinas, São Paulo, Brazil; Sr. Raul Briquet, Jr., Professor in Animal Breeding, Belo Horizonte, Minas Gerais, Brazil; Dr. E. R. Sears, Research Associate, University of Missouri, Columbia; Pvt. Richard Speairs, of Scott Field, Ill.; Dr. Ralph S. Hervey, of the U. S. Department of Agriculture, Bureau of Plant Industry; Sgt. Gerald B. Ownbey, formerly Research Fellow at the Garden; Dr. C. R. Odel, orchid enthusiast, of Houston, Texas; Dr. H. I. Featherly, Professor of Botany, Oklahoma Agricultural and Mechanical College, Stillwater; Miss Martha Thurlow, Librarian, Department of Biology and Chemistry, University of Texas, Austin; Mr. Leslie Hubricht, of Norfolk, Va., formerly Research Assistant at the Garden.

SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

THE MISSOURI BOTANICAL GARDEN

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MISSOURI BOTANICAL GARDEN BULLETIN

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Cover: *Nymphaea* "Missouri," a night blooming tropical water-lily created at the Garden.

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Missouri Botanical Garden Bulletin

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THE HOPI SUNFLOWER

CHARLES B. HEISER, JR.

Agriculture began with the dawn of civilization, and accordingly we must look to prehistoric times for the origin of most, if not all, of our important cultivated plants. To study the origin of a great many of these plants we would have to go to Eurasia, and to trace the origin of the important plants which were first cultivated in this hemisphere we would have to turn either to South or Central America. However, one plant—the sunflower—a native of the Great Plains region, does seem to be an important contribution of this country. The sunflower, called *tceeqa' aqaw' u* by the Hopi Indians of northern Arizona who have grown them for as long as we have record, may give us important clues to the beginnings of the cultivation of this plant. Hopi sunflowers were grown in the economic garden of the Missouri Botanical Garden during the summer of 1945 from seed kindly supplied by Miss Katharine Bartlett of the Museum of Northern Arizona.

The fact that these plants, as well as the wild sunflowers, play a very important role in the rituals and dances of these Indians is very significant. Alfred Whiting[1] lists several other uses of sunflowers. The plants of the huge golden flower are most highly valued for their large purple seeds, so dark as to appear almost black. Jimmy Kewanwytewa, a Hopi who now serves as Assistant at the Museum of Northern Arizona, related to me how it was one of the delights of the Hopi boys to obtain a few of these seeds when their elders weren't looking and to eat them much as we do the peanut. These seeds were a source of food, but of still greater importance and probably the prime reason for their cultivation were for the purple dye that they yield when boiled in water. This dye is a very useful source of color for the basketry and textiles, and a body paint for ceremonial use. A lesser use of the plant is for construction purposes where the stems are

[1] Ethnobotany of the Hopi. Mus. North. Ariz. Bull. No. 15. 1939.

employed when an extremely light "wood" is needed. They are probably used mainly in making a ventilation hood over the *piki* stone which is used for the baking of the *piki* bread.

The methods of cultivation by the Hopi are of particular interest to us —the more so when we contrast them with modern agricultural methods. To-day the Soviet is the world's foremost producer of sunflowers, and in this country the states of Missouri, Illinois, and California grow practically all of the sunflowers for commerce. Their chief use in this country at present is as scratch feed for poultry.

For the details of the growing of the Hopi plants I am again indebted to Miss Bartlett and Jimmy Kewanwytewa. I quote from Miss Bartlett's letter:

> ". . . I have consulted Jimmy on the planting of the Hopi sunflowers. He says that they are planted in the fields in sandy soil along with beans and watermelons and at about the same time in early May. They do not plant whole fields of sunflowers, but put in one or two rows in a field. They plant perhaps one row 50 yards long, or two rows 25 yards long, etc. . . . Three or four sunflower seeds are planted with a planting stick in a hole about 3 or 5 inches deep, and about 4 feet apart. The soil is broken up carefully so the plants can push through. When the young plants come up they are protected by a windbreak, to keep them out of the wind and prevent their being buried by sand. A bunch of brush is stuck into the ground or a slab of stone set up on the windward side. When the plants are well started they are given no further attention. They are not cultivated, as that disturbs the sand which blows away. In late September, they watch the plant carefully and cut the heads just before the seeds are ready to fall. They take the heads to the pueblo and dry them in the sun; and when they are very dry, they knock the heads together and the seeds fall out."

The heads grow much larger in the one pueblo which has irrigation than they do in the other pueblos.

A careful comparison of the Hopi sunflower with other sunflowers brings out several differences. First of all, it is important to realize that there are numerous cultivated strains of sunflowers to-day. The gray-striped or Mammoth Russian variety is one of the most widely known and also must have been in cultivation for many centuries. Plants of this variety were grown beside the Hopi plant at the Missouri Botanical Garden for preliminary study and crossing experiments. To-day the Hopi grow a limited number of these sunflowers also which they have obtained through the regular seed channels. The most striking apparent differences are those of color. The Mammoth Russian plants have gray striped seeds whereas the Hopi plants have shiny deep purple seeds. There is also a difference in shape which may be seen in the photograph (fig. 1). The difference in the seeds was impressed upon my mind when I left seeds of both types on my desk, and the next day found that mice had eaten every one of the striped seeds but had not touched the purple ones!

Fig. 1. Sunflower seeds

Upper row: Large striped seeds—Russian Mammoth; small black ones—common sunflower *(Helianthus annuus)*. Lower row: Hopi sunflower.

After the seeds have germinated we note another difference. The hypocotyl or young stem of the Hopi sunflower is a deep reddish color and that of the Russian plant is usually greenish or a very light red, a difference that may be correlated with the other color differences. Moreover, in the seedlings we see that the hypocotyl elongates much more rapidly in the Hopi plants than in the Russian. This, of course, may be due to the fact that selection has played a role because the Hopi has always planted his seed rather deep.

In the heads of the flowers another color difference appears. The disk is brownish or purplish in the Hopi plants when seen from a distance and that of the Russian appears golden. Upon careful examination with a lens we find that the tiny flowers composing the disk in the former are yellow with red corolla lobes whereas they are entirely yellow in the Mammoth

Russian. Most of the wild annual sunflowers and certain other cultivated varieties have the disk brownish or purplish also.

At first glance the leaves appear almost identical but closer study discloses certain minute differences. The Hopi plants have a shiny, deep green leaf, while the leaf of the Mammoth Russian is lighter green, sometimes larger and deeply cut around the edges. Furthermore, there seem to be slight differences in the decurrence of the leaves, and the bracts of the heads also may show some difference in shape, color, and hairiness. Sunflowers resembling the Hopi plants have been found in one locality in Mexico, and V. H. Blackman, of the Imperial College of Science, London, writes me that the Russians to-day grow a variety with seeds very similar to those of the Hopi.

Three species of wild or weed sunflowers are reported as growing in or near the Hopi Reservation by Whiting.[1] The Indians utilized at one time, and even to-day to a certain extent, many of the wild plants growing about them. The wild sunflower appears to have had several uses. We find that they often served as adornment during various dances, that a dye is obtained from their yellow ray flowers, and that in addition they seem to have been recognized as a medicine for spider bites. The Indians had a saying that when the sunflowers were numerous there would be an abundant harvest.

The most important of the weed sunflowers is the one known scientifically as *Helianthus annuus* from which the cultivated varieties are thought to have been derived, but exactly how the giant plant came from the wild one is still a mystery. The Hopi sunflower may offer us a clue in the solution of this riddle, for in many ways it appears more closely related to the wild plant than does the Mammoth Russian variety. The greatest difference between the wild and cultivated plant is one of size and the restriction of branching in the cultivated plants.

All in all, we know that sunflowers played a rather important part in the lives of primitive man. Although, according to Whiting, "the modern Hopi received it as a cultivated plant",[2] the study that is being undertaken on this plant may yield significant data toward finding the origin of cultivated sunflowers.

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[1] Mus. North. Ariz. Bull. No. 15. 1939.
[2] Mus. North. Ariz., Mus. Notes No. 10:14–16. 1937.

WILD ANIMAL LIFE AT THE ARBORETUM

AUGUST P. BEILMANN

If a sizeable tract of land is under protection for a number of years an increase in the number and kinds of animals might be expected. However, this increase would follow only if the area were protected from fire, were not grazed too heavily, and if an effort were made to restore the original environment. For instance, we would not expect a growth in quail population if conditions were not favorable, nor would we expect to find many deer if the whole tract were extensively cultivated. In other words, the most modern farming which leaves no grown-up fence rows is not suitable for birds nor will highly cultivated fields prove satisfactory for sheltering deer. The twenty years in which some parts of the Arboretum have been set aside as wild-flower reservations have seen an increase in game ranging from ground hogs through deer, wolves, and finally beaver.

The Virginia white-tail deer probably drifted away from the state parks farther west or were driven to the refuge by dogs from the outskirts of Meramec State Park. Deer have been present at the Arboretum since about 1936, but not until 1939 did they make their presence known by feeding on soybeans. In the ensuing years the herd has increased until the fifteen animals present to-day seem to represent about the normal population for this region. Of course, more deer per acre could be carried if the Arboretum were fenced and all predators eliminated. But since these deer are able to come and go as they please, the hazards of living so close to civilization will probably keep the population in check. During the last twelve months, at least two of them have been struck by cars while crossing Highway 66. Then there are some so-called "fox hounds" which run deer at every opportunity, day or night, in and out of season, and they can drive deer into a section less capable of supporting them and where the every-day hazards are even greater. Deer behave very much like cattle. They are creatures of habit, feeding during certain parts of the day, traveling for water at another time, and usually hiding in the brush during the heat of the afternoon. It has been shown that the degree of browsing is an indication of the population on any given range. We have learned to expect some feeding on a field of germinating soybeans, but browsing on crabapples or dogwood has not been noticeable. On the other hand, these deer are particularly fond of emerging lily shoots. A planting of Regal Lily must be fenced, and lately there is an indication that the flower buds of Rhododendrons are particularly attractive. On the whole, though, the deer have done little harm, and a visitor is likely to find the sight of two six-point bucks calmly grazing on a meadow as interesting as any rare wild flower.

The presence of wolves in the area would seem to indicate that we had reached some stage of biological equilibrium in the development of the Arboretum. While the wolf is known to have invaded most of the eastern states in recent years, it is also true that he could not exist unless conditions were favorable. So far as we know, wolves do not kill deer; their diet consists largely of carrion supplemented with mice for which they dig, and of squirrels, rabbits, and ground hogs, which they can run down. Little more can be added to the story of wolves than appeared in the December 1943 BULLETIN, except to increase the number killed to fifteen and to restate that many of these animals have a dog as one parent.

The beaver has been at home along the Meramec River for several years, having undoubtedly come from the State Park at Sullivan. Beavers are noted engineers and capable of constructing huge dams across small streams. Along the Meramec, however, they seem to have been content to use existing brush piles and to add only a limited amount of mud and logs to complete a suitable house. They have a preference for cottonwood *(Populus* sp.) as a food, and they do eat willow *(Salix* sp.) at certain seasons. Unfortunately, their feeding habits are not as cosmopolitan as they should be if the animals hope to exist in a civilized community. Although they have broken with tradition to the extent that they can and do raid corn fields, the injury to any particular corn field has not, in the writer's opinion, been as serious as ground hogs usually inflict. The beaver is almost entirely nocturnal, and the average fisherman may spend days on the Meramec unaware that he has been a close neighbor of a colony. As they go about their business of feeding and building they often slap the water with their flattened tails. The noise resembles a pistol shot, and when heard sporadically through a dark night it has been known to frighten less hardy fishermen into going home, much chastened, and without a single story of "the one that got away."

Both the gray and the red fox can be found, but they are noted for their cunning and are not frequently seen. On occasion, they are visible in the headlights of a car as they dart across the road at night. Unless they chance to learn to raid poultry yards, their food habits will probably cause little harm. We are inclined to believe that they assist in checking the rabbit population. However, they may be capable of killing quail and other ground-nesting birds, and we believe they had a hand in the destruction of nine Canadian geese which were placed on the lake some years ago.

Ground-hog dens can be found everywhere from the river flood-plain to the highest hill. Their presence in a refuge is not objectionable, except where they raid experimental corn fields or where they begin tunneling in

dams and road banks. Recently this animal has gained some prominence as a means of stretching the meat ration, and in some sections of Missouri it has always been considered a table delicacy. Our ground hogs seem more closely related to the marmots of the West; at least they sit up and whistle much more than does the eastern woodchuck.

In winter the tracks of mink can always be found along the water courses; occasionally the animals can be seen in day time. They are great travelers and great killers, quite capable of attacking our largest birds and any small animal not gifted with speed or fighting ability.

Muskrats are present along the river where they burrow in the bank. Several years ago a colony became established in the Pinetum Lake and in the quiet water built the typical conical house of cat-tails and mud. In the Arboretum, their feeding habits cause no damage. When a colony is well established, individuals can often be seen swimming and diving during some part of the day.

"Possum and coon" are always linked together—in name at least. They are the largest game hunted with dogs at night. Both animals are well established at the Arboretum, and their tracks can be seen almost any day. The raccoon, of course, is nocturnal and never seen and seldom found unless hunted with dogs. Both the "coon" and "possum" live in the mature timber, but their food habits differ greatly. The "coon" is very fastidious, while the "possum" will eat anything from carrion to wild fruits and often can be found in the winter hunting for dried fruits in the crabapple orchard.

Both the gray and the red fox squirrel are common, as well as the nocturnal flying squirrel. Probably they are all-important sources of food for larger carnivorous animals. At the same time, they are great planters of tree seeds, and without their assistance the better oak trees would have a very limited distribution. The flying squirrel is not over one fourth as large as the gray and, being entirely nocturnal, is never seen. It is most active during moonlight nights when its squeakings may be mistaken for that of a bird or a frog. In captivity, it will eat anything from carrots to hickory nuts, and when mature hardly weighs more than six ounces.

The skunk population is falling, due perhaps to predators or perhaps to lack of food and den sites; at least they are less common now than they were in 1939. At that time they could be seen very frequently both in the day-time and in the headlights of a car at night.

The rabbit population rises and falls in cycles. At the present time it is greater than it has been for six years. A few cottontails scurrying about are interesting, but when we note an upswing in their population we also hope for an upswing in that of the fox and the wolf. Without some natural

check, either disease or predators or both, it would be necessary to protect nearly every plantation on the grounds. With many thousands of plants in the nursery and many more thousands permanently planted, we have cause for alarm when we see the cute little "bunnies" dusting themselves on every roadside.

The Arboretum was designated as an inviolate game refuge some six years ago by the Conservation Commission. This means that no hunting of any sort is permitted and that authority of the Conservation Commission extends even to the picking of wild flowers, trees, shrubs, and vines. Since that time, we have become increasingly interested in the welfare of the birds and animals, just as we had always been interested in the behavior of the plants. It may seem strange that a botanical garden should pay attention to the animals making a home among the plants and trees. As a matter of fact, we have come to believe that the kind of animals which succeed in living on the grounds is an index to the quality of the botanical effort. For instance, if the deer are capable of living here under seemingly natural conditions, then surely we have begun to reestablish the kind of territory over which the Osage Indian hunted in 1800. Neither plants nor animals can succeed in an unfavorable environment. Plants can not tell us what they need nor what is missing, but the unfenced animal is always free to move to a better location. An introduced wild flower perishes, leaving us to fill in the blank spaces as best we can, but birds and animals released on an unfavorable range simply leave or disappear. There is very much interdependence between plants and animals, and when we succeed in increasing the animals without the use of fences we believe we are travelling in the right direction toward the reestablishment of that most complex community—the wild flowers, the grasses, the vines, and the trees. We have achieved a state of biological balance when the game returns and when the disappearing plants begin to increase in number.

WHY PLANTS BLOOM OUT OF SEASON

DAVID C. FAIRBURN

Frequent inquiries come to the Garden about various plants flowering entirely out of season. Magnolias that normally bloom in spring produce a second crop of flowers in midsummer; Forsythia bushes bloom intermittently until frost; and hardy chrysanthemums start flowering in summer instead of late fall. It is difficult, if not impossible, to determine the exact reasons for many plant growth responses. The chemical, physical, and biological reactions which occur in and around the plant are so interwoven and com-

plex that an accurate diagnosis of unusual plant behavior is often purely accidental. But since speculation is not on the ration list yet, here are a few opinions regarding the case in hand.

In the first place, it will be noted that out-of-season flowering occurs during years when abnormal weather conditions prevail. A wet spring followed by a very dry summer and a long, warm, wet fall can force fruit trees into full bloom just prior to frost. It is of course very detrimental, sometimes even fatal, for the trees to be forced into active growth when they should be practically dormant and ready to withstand the rigors of winter. Prolonged cloudy, wet spells in spring and early summer tend to force fall-blooming plants into flower a month to six weeks or more earlier than normal. These fall-blooming plants (chrysanthemums, most of the perennial asters, the late cosmos, etc.) are what we call "short-day" plants. They produce flowers only when the daylight period is reduced to twelve hours or less. On the other hand, there are many garden ornamentals that are "long-day" plants, blooming only when the daylight period is fifteen or more hours in duration.

Temperature is another controlling factor in the growth responses of plants. For example, most varieties of head lettuce "bolt" (go to flower and seed) when the prevailing temperature at midday rises above 80° F. in the shade. Tomato flowers do not set fruit very well when the day temperature goes to 95°–100° F., and fruits that have already formed are likely to develop "blossom-end" rot. However, such disorders are probably due in part to water deficiencies within the plant.

These are but a few examples of the influence of light intensity, water, and temperature on plant growth. Nutrition and photosynthesis are other important controlling factors. If all these environmental conditions are ideal, vegetative growth and flower production occur normally; but when one or more of these gets out of balance, anything can happen, and it usually does.

Briefly, it is known that flower production is definitely associated with an accumulation of carbohydrates in the plant. Any external or internal factor that brings about such a condition will cause the plant to bloom any time the weather permits. Forcing plants into bloom out of season is common practice in the greenhouse. It is not surprising that Mother Nature takes pleasure in showing us a thing or two along this line occasionally.

EUROPEAN BOTANIC GARDENS AND THE WAR

A LETTER FROM FRED G. MEYER

The following excerpts of a letter from Fred Meyer, a former Garden student, who has been stationed in England during a part of the war, should be of interest to those who have been wondering about the present status of the great English horticultural institutions.

Near Rouen, France
31 May, 1945

"My outfit moved over here from England two days after V. E. Day, and while waiting to be set up again we are at a transient camp about four miles out of the city of Rouen. We have been here about three weeks now, and within the next few days we expect to move to Kassel, Germany, where we are told our hospital will be.

"As you may know, my interests lie primarily in horticulture; consequently, in all my visits to gardens I made especial note of cultural methods and of plant varieties which would be of value in the States. While stationed in England I visited the Edinburgh Botanic Garden on two different occasions. As I am very much interested in Rhododendrons, I made a point of visiting that institution during April, when they were at their best. If you have seen the Rhododendrons in flower there you will agree that they are a sight long to be remembered. I was greatly impressed with the Edinburgh Botanic Garden because it is not too large and it is well kept, and the climate admirably suits a great variety of plants, especially Himalayan. As far as the war having affected them, it really hasn't to any great extent. Labor shortage has necessarily cut down on many of their propagations and outdoor work, and much of their scientific work has by necessity been curtailed. However, they were never bombed.

"I also visited Kew, with Gerald Ownbey [another former Garden student], but our time was very limited on that trip. Kew is in somewhat the same circumstance as the Missouri Botanical Garden, that is, being near the city and affected somewhat by city smoke. However, what I saw there did impress me, and the age of many of the plantings adds immeasurably to the beauty and refinement of the Garden. Unfortunately, Kew has suffered some by bombings. On several occasions bombs have dropped in the Garden, and the glass in some of the houses was totally destroyed. In the early part of 1944 a bomb landed about a hundred yards away from the Temperate House, and practically all the glass in that house was shattered. Many plants were torn to shreds, and only by quick work were the most badly blasted sections covered with canvas and the remainder of the plants saved.

I saw the house in March of this year, and you wouldn't know anything had ever happened.

"Another famous garden that I visited just before we left England was the Lord Aberconway estate, Bodnant Gardens, in North Wales. This garden possesses a marvelous collection of Rhododendrons and other temperate trees and shrubs. I was greatly impressed with their hybrid Rhododendrons. Mr. F. C. Puddle, the head gardener, has been concentrating on low-growing forms for small gardens. For instance, he has crossed *R. repens*, which is a prostrate species with fine red flowers but a sparse bloomer, with *R. Griersonianum*, which is a half-hardy but normally tall-growing species. The hybrid is an intermediate that is entirely hardy and very floriferous. He has also what is probably the largest collection of pure white Cypripediums, the var. 'F. C. Puddle.' He says there are none of this variety in the States, —at least he knows of none. As eager as people in the States are for white orchids I can imagine what they would do if they could get a white 'cyp'.

"Since being in France I was fortunate enough to be able to go to Paris with a group from my outfit for a day tour. One day is much too short in Paris—but you can be sure I made the most of it. I visited the Jardin des Plantes, and spent enough time there at least to see the effects of the war and the kind of botanical work that is being carried on. In the herbarium it was interesting to thumb through sheets of Tournefort's, Jussieu's, Lamarck's, and Michaux's specimens. Unfortunately, the library is split up all over the building, which makes it difficult to use.

"I asked my guide at the Jardin des Plantes whether they had been molested during the occupation, and was informed that they hadn't been. Of course, it is impossible to get paper so nothing has been done in the way of publication since 1940. The outdoor gardens are not especially extensive. There are roses, peonies, a medicinal garden, an alpine garden, and other small gardens with exotics. The most disheartening thing about the whole garden is its loss of nearly all the tropical plants last winter. Due to the lack of coal the houses could not be heated, and everything froze. I was told there had been some fine collections of Madagascar plants and other rare things. Imagine all the plants at the Missouri Botanical Garden freezing and having to start from scratch again! Perhaps it is better to just vanish the thought."

VANDOPSIS DAVISII

A NOTEWORTHY PHILIPPINE ORCHID—*VANDOPSIS DAVISII*

GEORGE H. PRING

In June, 1931, a small plant labelled *Staurochilus Davisii* was among the orchids in the Philippine collection received by the Garden from Governor-General Dwight F. Davis. This plant, which is now identified as *Vandopsis Davisii,* flowered on May 12, 1945 and continued in bloom until it was cut for the Garden Herbarium on July 9. As far as we are aware, this is the first time that this species has flowered outside the Philippines.

Vandopsis Davisii was described by Oakes Ames and Eduardo Quisumbing in the *Philippine Journal of Science* in 1932. It was named in honor of a St. Louisan, Dwight F. Davis, being dedicated to him "for his interest in orchids and particularly for his unselfish devotion and interest in his work when Governor-General of the Philippines." According to the authors, the plant was cultivated at that time in the Bureau of Science Orchid House and in two gardens at Manila. Orchid peddlers in that city stated that the plants had been collected from the mountains near Montalban, Rizal Province, Luzon.

The following is an excerpt from Ames and Quisumbing's description of the plant (Philip. Jour. Sci., Vol. 49, p. 498):

In floral structure it resembles *Vandopsis lissochiloides* (see Garden BULLETIN, Vol. 27, pl. 37.) Plant 8–23 inches high. (The Garden plant is now 12 inches high and possesses 8 leaves about 10 inches long and 1 inch wide.) Leaves leathery, strap-shaped, channeled through the middle. Flowers fragrant, firm; sepals and petals white on back and front washed with Lumiere Green* or Light Lumiere Green, and spotted with Claret Brown on the petals and Raw Umber on the sepals; lateral lobes of the labellum pale Viridine Yellow; middle lobe of the labellum white, spotted with Ox-blood Red above, on both sides of the keel above and Empire Yellow at the very tip of the tongue; callus at the base of the labellum between the lateral lobes cuplike, white, light Orange Yellow within.

* Technical color terms are those of Ridgway, Color Standards and Color Nomenclature. 1912.

YOUR QUESTIONS ANSWERED

How may weeds in a driveway or tennis court be destroyed?

A number of preparations may be applied with effective results. Iron sulphate may be used at the rate of two pounds to a gallon of water; two gallons of this solution should cover about 100 square feet. One of the newer weed poisons, known as Weedone, is also highly recommended.

May potted hydrangeas, which were purchased from the florist, be planted outside?

Some of the so-called florists hydrangeas are not suitable for planting outdoors, because the flower buds freeze each winter. The only way to prevent this is to cover the plants with a box or barrel filled with dry leaves or straw. Placing tar-paper over the top helps to shed the rain. If the stems or branches which are formed this year are brought through the winter without being frozen flowers should develop the next year. If, however, the canes are frozen back, then the flower buds are also destroyed.

How can cuttings be made from a rubber plant?

Rubber plants can be propagated by regular tip cuttings or "slips" such as you would make from geraniums. Another method is by air-layering. About 10–12 inches from the tip of the main stem make an upward cut through a joint and about half-way through the stem. Prop the cut open with a match and wrap the wound securely with a ball of wet sphagnum moss. Keep the moss damp at all times until roots form at the cut, two or three months later. Then sever the stem below the moss and pot up the rooted section. The lower portion, or mother plant, should in time develop two or more new shoots.

What can be done to eliminate lice and aphids from nasturtiums?

Apply nicotine sulphate or "Black Leaf 40" spray (one teaspoonful to a quart of water) once each week until the aphids or lice disappear. Be sure to spray the under side of the leaves as well as the top.

How should potted geraniums be cared for?

During winter keep the plants in south windows where they will have full sunlight. The soil should be moist, but never soggy. In spring when growth is rapid, give each plant a weekly watering with liquid fertilizer (one teaspoonful of any complete fertilizer to one quart of water). During summer move the plants outdoors where they will have fresh air, sunlight, and rain. They may be taken out of the pots and planted directly in the garden if desired.

If you want to increase the number of plants: during the spring or fall cut off slips 3–4 inches long, remove two or three of the basal leaves, and "plant" the cuttings in moist sand. When a root system has developed (about 6 weeks) pot them in soil. Good results are also generally obtained by potting them directly in soil.

How should canna roots be cared for during the winter?

Just before there is danger of heavy frost, cut the canna stalks to within six inches of the ground. Dig the roots with some soil around them and store in the coolest part of the basement but not where the temperature goes below 45° F. If the roots are packed in boxes of peat moss, sand, or soil, there is little danger of them becoming too dry. Examine them several times during the winter and if they are shriveling sprinkle the boxes lightly about once or twice a month.

When and how should spireas be pruned?

The Bridal Wreath, *Spiraea Vanhouttei*, is the spiraea most commonly planted in gardens. It grows about six feet high and produces many slender, arching stems, which makes it a little more difficult to prune than most kinds of shrubs. A young plant may be left to grow for several years without any pruning but in time it will become top-heavy. Removing a few of the oldest canes each year will preserve the shape for some time. This pruning may be done immediately after the shrub has bloomed or during the fall or winter. If the spiraea has become overgrown or pruning has been neglected do not try to reshape it but replace it with a young plant.

When and how should a lilac be pruned?

A lilac needs very little pruning the first few years, but as it grows older the thin and weak wood should be removed during the dormant period. An own-root lilac should have many of the suckers removed to prevent the plant from becoming too broad, and all suckers around a grafted lilac must be cut away. Old canes injured by borers should always be removed. One type of pruning which should not be neglected is the removal of the spent flowers before they set seed.

How should begonias be cared for? Can they be divided?

There are so many different kinds of begonias that only a general statement can be made as to their care. They grow best in the greenhouse but some of them do reasonably well in the home if it is warm and there is an abundance of moisture around the plants. During the summer they grow better outdoors in a shaded part of the garden. When in active growth begonias need feeding with liquid cow manure or one of the prepared plant foods. They should be fed often but lightly; a single heavy application might injure the plants.

The common fibrous-rooted begonias can be propagated by division. To do this, remove the plant from the pot, divide it into several pieces, then repot in fresh soil composed of two parts loam, one part sand, and one part well-rotted manure. If barnyard manure is unobtainable use the dehydrated and sterilized cow manure.

NOTES

Mr. George H. Pring, Superintendent of the Garden, represented the Missouri Botanical Garden at the meetings of the American Orchid Society, at Chattanooga, September 14-15. On September 26 he attended a meeting of the Board of Directors of the Houston Flower Show, to which he was asked to speak on staging flower shows in St. Louis.

Dr. Henry N. Andrews, Assistant to the Director and Paleobotanist, spent two weeks during September collecting fossil plants in southeastern Idaho. This was in continuation of earlier exploration in Idaho and adjacent portions of Wyoming. Quantities of petrified fern trunks were collected that are of special interest since they represent plants that link Coal Age fossils from Illinois with certain elements of the subtropical flora found today in the Florida Keys.

Recent visitors to the Garden include: Dr. Arthur Cronquist, Assistant Curator, New York Botanical Garden, Bronx Park, N. Y.; Dr. Harlan Lewis, of the Department of Botany, University of California, Los Angeles; Pvt. Mas. Yamada, of the U. S. Army, formerly graduate student at the Garden; Mr. Julian Neill, Teacher of Botany, East St. Louis High School, Ill.; Mr. Walter C. School, orchid enthusiast, of Chicago, Ill.; Mrs. W. D. Diddell, botanist and plant collector, of Jacksonville, Fla.; Mr. H. Brossman, Acting Superintendent, Mitchell Park Conservatory, Milwaukee, Wis.

The September number of the ANNALS OF THE MISSOURI BOTANICAL GARDEN (Vol. 32, No. 3) was issued during the month, with contents as follows: A Revision of the Genus Schkuhria, Charles B. Heiser, Jr.; Multidimensional Graphical Representation for Analyzing Variation in Quantitative Characters, Ellen Marie Kern and Charlotte Alper; Right-angle Grid System for Mapping Plant Distribution, Ellen Marie Kern; A Nectria Disease of Coffee in Western Guatemala, Dorothy Gaebler Heiser; A Preliminary Survey of Maize in the Southwestern United States, George F.

Carter and Edgar Anderson; Contributions to Our Knowledge of American Carboniferous Floras. VII. Some Pteridosperm Stems from Iowa, Henry N. Andrews; Maize in the Yanhuitlán Codex, Edgar Anderson and John Jay Finan; Notes on Some North American Asclepiads, Robert E. Woodson, Jr.

The Garden library has recently acquired the rare first edition of Darwin's "On the Origin of Species" published October 1, 1859. This edition of 1250 copies was exhausted on the day of issue. Comparing this with the next edition published in 1860, it is interesting to note that Darwin made several significant changes. Aside from the misprint "speceies" on page 20, which was corrected, he eliminated the famous reference to the possibility of a polar bear developing by natural selection into an aquatic animal "till a creature was produced as monstrous as a whale"; possibly because of the ridicule heaped on the author's argument. Even more significant is the insertion in the final paragraph of the words "by the Creator," so that it reads in the second edition: "There is grandeur in this view of life, with its several powers, having been originally breathed *by the Creator* into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been and are being, evolved."

THE MISSOURI BOTANICAL GARDEN

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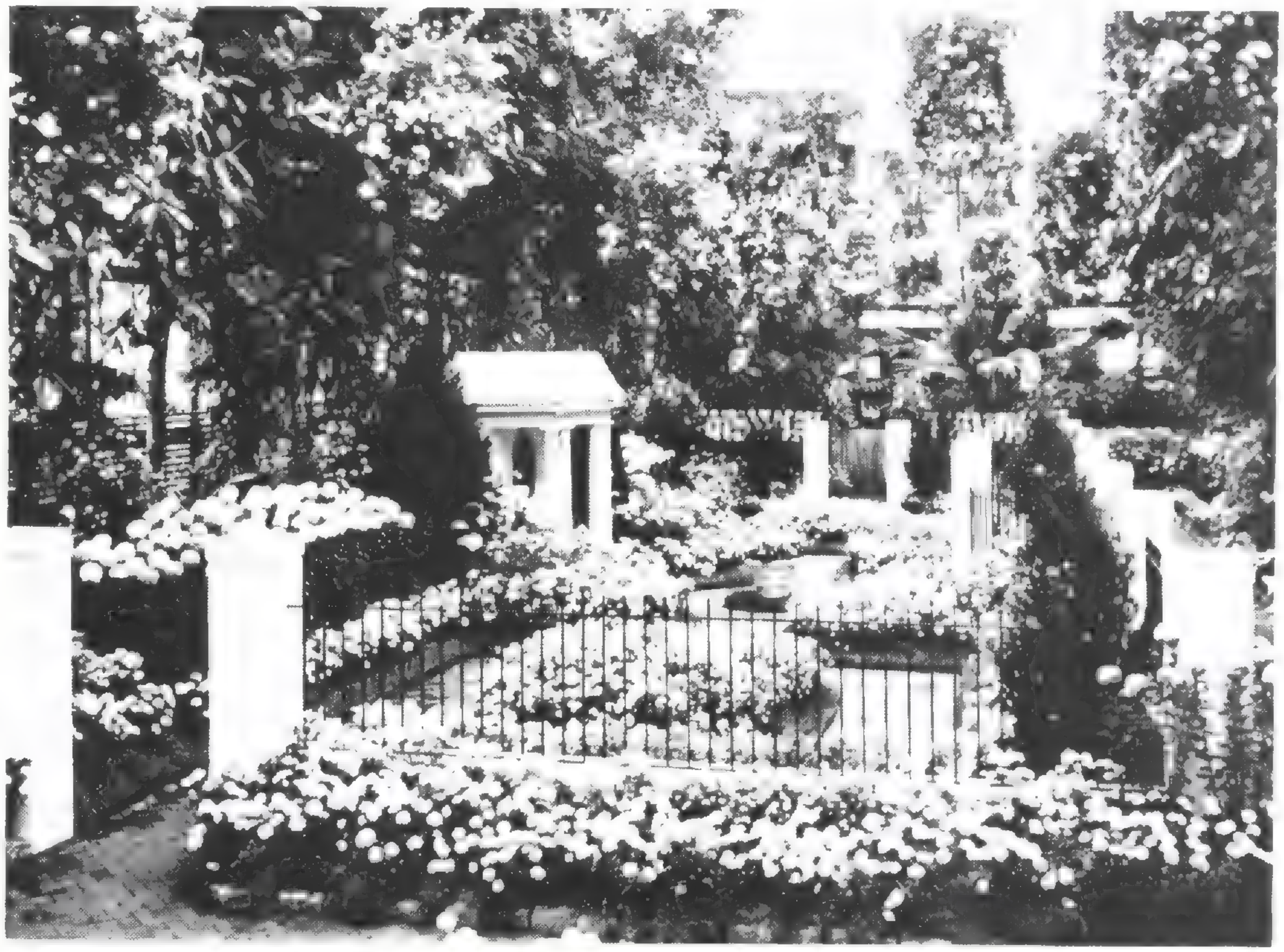
SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

MISSOURI BOTANICAL GARDEN BULLETIN



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Missouri Botanical
Garden Bulletin

GROWING PLANTS

During the past two decades the BULLETIN has presented a number of articles on plant propagation, the most recent of which appeared in April, 1941. Requests for this article continued unabated, and the issue was exhausted more than a year ago. As the present edition is considerably revised, both as to text and illustrations, it is hoped that it will be welcomed by both old and new subscribers.

I. GROWING PLANTS FROM SEED

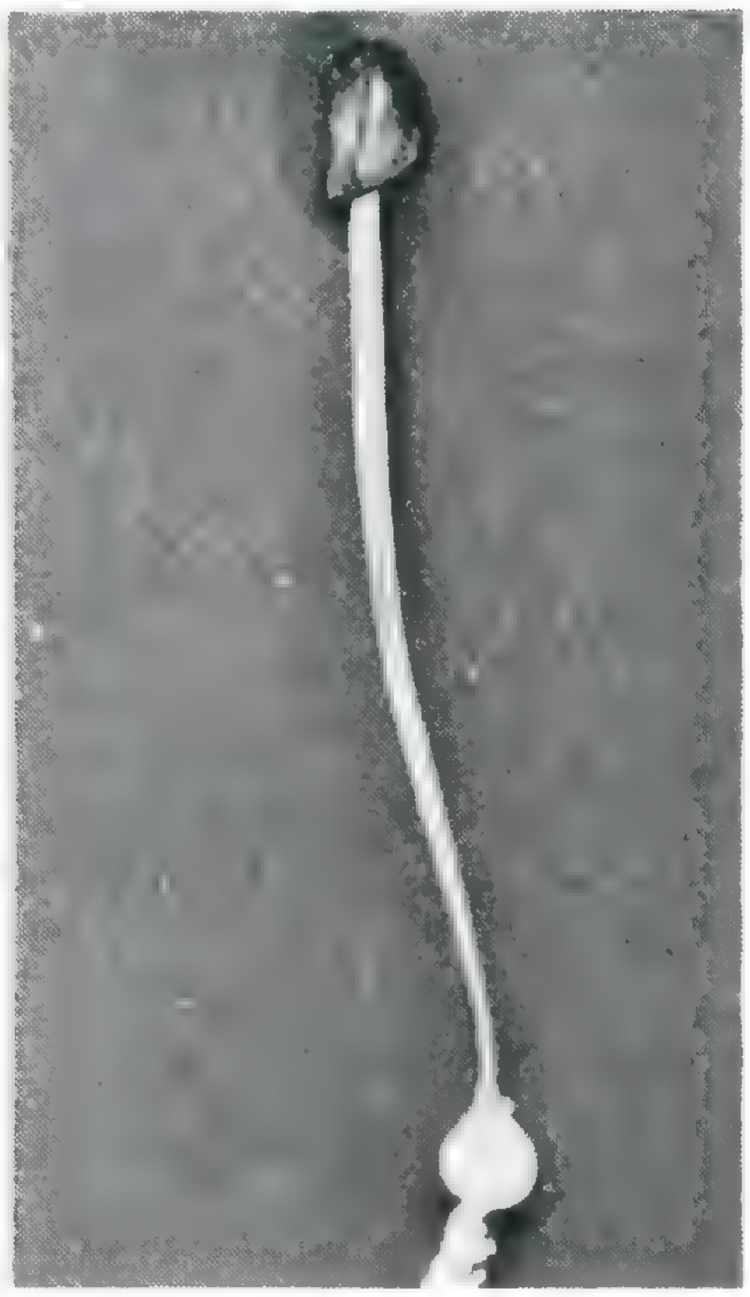
PAUL A. KOHL

The degree of success in raising plants from seed depends upon the manner in which the gardener sows the seed, the soil medium he uses, and the care that he gives the seedlings. Some gardeners are gifted with the fundamental knowledge of growing things and by intuition handle all kinds of seed correctly, but others strive through the long and laborious process of trial and error to master the comparatively simple rules.

Lily seed, which is as thin as paper and so transparent that the miniature plant can be seen by transmitted light, serves as a good example of seed structure. Seeds differ greatly in size, thickness, the amount of food they contain, and in the hardness and oiliness of the outer seed coat. The majority of seeds germinate within a few days or weeks after being sown, and there is no real difficulty in getting them started. Some seeds need a period of rest or dormancy before they are ready to grow, and others have such a hard seed coat that it must be cut or filed to permit moisture to enter. In some cases this can be accomplished only by the freezing and thawing action of the frost which splits the seed coat.

Planting time.—A few slow-growing plants, such as lobelia, petunia, snapdragon, vinca, broccoli, cabbage, and cauliflower, must be started as early as February in order to be large enough to set out in the spring. Other long-season plants, for example, ageratum, aster, nicotiana, verbena, zinnia, egg-plant, pepper, and tomato, should be started in March, or about six

Transparent lily seed showing embryo surrounded by endosperm.



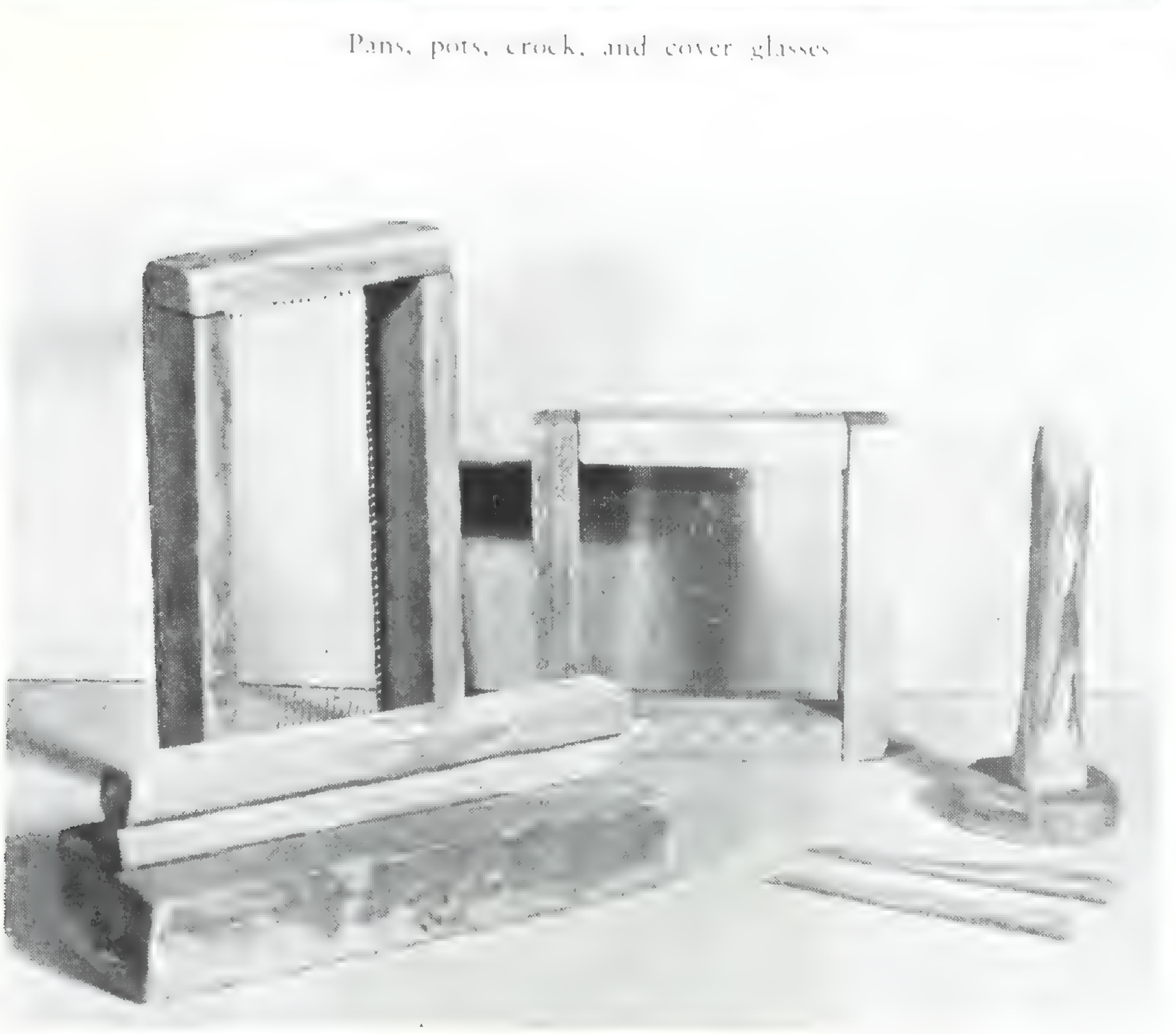
Lily seedling with seed-case still attached.

weeks before the plants are to be set in the garden. Seeds of various perennials may be sown in early spring, transferred to frames, and later planted in the garden. Perennials may also be started from June to August, planted out in the fall or held in the frame until the following spring. Seedlings started during the summer months are difficult to grow because of high temperatures, whereas those started in the spring are of sufficient size to live through the heat of the summer provided they are grown in a lath-shaded frame. Many kinds of seeds are sown directly in the garden, a few of them when the ground is still cold, but most of them after the danger of frost is past.

Place for early planting.—A small greenhouse is the ideal structure in which to start plants, but how few gardeners are fortunate enough to own one. The next best place is a sun-porch where the temperature does not go below 45° F. The third, and a very good and inexpensive structure for starting seeds, is the cold-frame. If the frame is used very early in the season, say in February, then an electric hotbed cable with a thermostat will be required. The disadvantage of using a frame is that at times it must be serviced during disagreeable weather, while with a greenhouse or a sun-porch weather does not matter.

Seedlings that are grown in frames are extremely sturdy, and for this reason they are moved from a greenhouse or sun-porch to a frame to be

Pans, pots, crock, and cover glasses



Sieves, tampers, and dibbers

hardened-off, or accustomed to the outside temperature, before being planted in the garden. In locating the frame, a position should be chosen that is sheltered on the west and north by a fence, building, or shrubbery. The frame should be sloped to the south to catch the sun's rays and to carry off the rain. If near-by buildings shade the garden during a part of the day, a position receiving the morning rather than afternoon light should be selected. When seeds are sown in the spring it is essential to secure as much sunlight as possible. However, if they are sown in July and August the problem is to reduce the amount of sunlight, this being accomplished by placing the frame with the slope to the north and placing over it shades made from plastering laths.

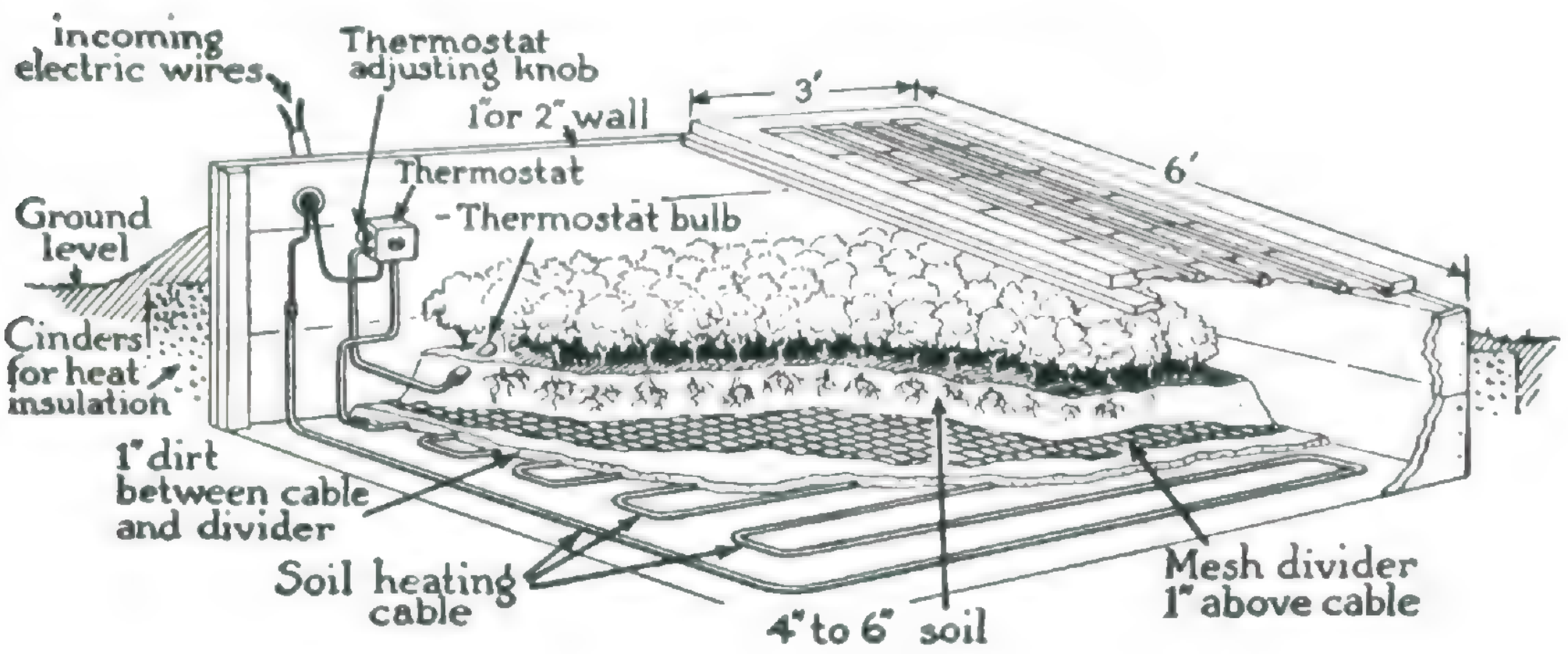


Fig. 1. General Electric layout for an electric-heated hotbed.

The last, but by no means the poorest, place to start plants is on a well-lighted window sill. If possible, the window garden should be supplemented with a cold-frame in which plants may be grown until planting-out time.

Pots, boxes, etc.—Earthenware flower pots and pans and special boxes termed "flats" are the best containers in which to start seeds. Two convenient sizes for flats are 10 x 20 x 3 and 14 x 20 x 3 inches. Metal cans, discarded graniteware, and any other containers in which drainage holes can be punched in the bottom make good substitutes for flower pots when the latter are not available.

Drainage.—No matter what type of receptacle is used the bottom should have means to drain off the excess moisture, otherwise the soil becomes sour and the plants die. If the boxes are of wood several holes should be bored through the bottom or the boards should be spaced at least a quarter of an inch apart. If the boards of the flat are too close they will swell when moist and make the box water-tight. Even though drainage is provided,

it is well to place some coarse material in the bottom of the receptacle to prevent the fine soil from clogging the holes or cracks. For this purpose pieces of broken flower pots (termed crocks), gravel, stones, and cinders may be used.

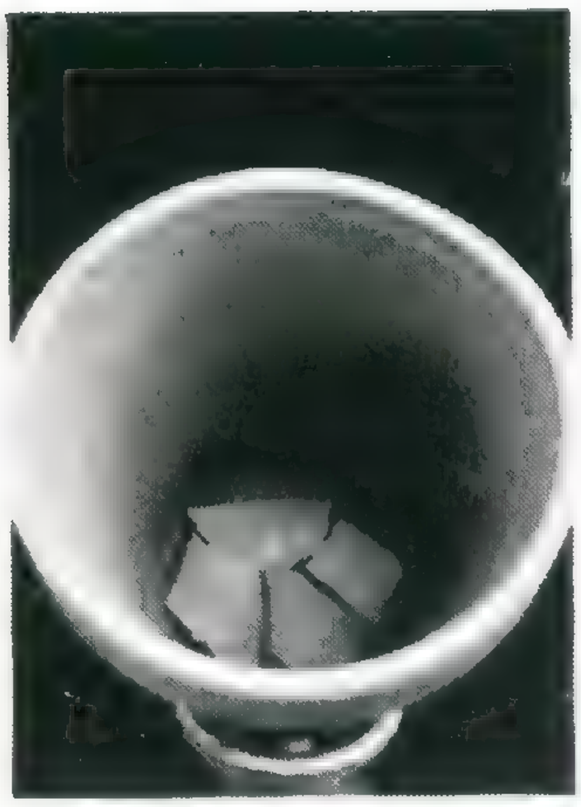
Flower pots and pans come in various sizes according to diameter. A four-inch pot is the smallest size that should be used for sowing seed. When only a very small quantity of seed is to be sown it is best to use a flower pot, the seed being broadcast over the surface. If many kinds of seeds are to be sown, most of which will germinate in about the same length of time, much space can be saved by sowing them in rows in boxes or large pans.

Sieves, tampers, dibbers, labels.—Any one interested in growing plants from seed should secure some essential tools. They are all very simple and can be easily made. Sieves simplify the operation of sowing seed, especially fine seed, and once they are used they become a necessity. A fine-mesh screen need not be more than 6 or 8 inches square, but a coarser one for sieving large quantities of potting soil should be 1 x 2 feet or larger. A fine screen may be made by tacking a piece of window-screen wire cloth to a wooden frame. For coarser screens wire screening $\frac{1}{8}$, $\frac{1}{4}$, or $\frac{1}{2}$-inch mesh is used, the size of the mesh depending upon the nature of the soil and the purpose for which it is wanted. It would not only take a very long time to sift through a fine sieve all the soil necessary for some zinnias, but also it would not be best for the plants. Finely sifted soil packs with repeated watering, thus excluding the air. The soil then becomes sour, and the plants grown in it become stunted.

Watering cans and methods of watering.—The average sprinkling can sold in the stores throws a rather coarse stream of water. Extremely fine seeds being barely pressed into the soil when sown are often washed away with a heavy stream. Better types of cans may be purchased from seed stores and florists' supply houses. A rubber bulb sprayer, the kind used in the laundry, is a good substitute for a sprinkling can when only a few pots of seed are watered.

One of the newer methods of watering, and one which insures a constant supply of moisture to the seedlings, is by means of a fibre-glass wick inserted through the drainage hole of the pot. Water is brought up from a reservoir in the same way as oil moves up the wick of a lamp. If the soil should become too wet, however, some adjustment must be made by supplying water only periodically. The frequency of watering by the wick method will be governed by the type of soil, atmospheric conditions, and the number and size of the seedlings in the pot.

POTS AND LABELS



DRAINAGE

LEVELING SOIL

TAMPING

SOWING SEED

COVERING SEED

WATERING

GLASS OR
PAPER COVER

GERMINATION
REMOVING COVER

SEED-SOWING

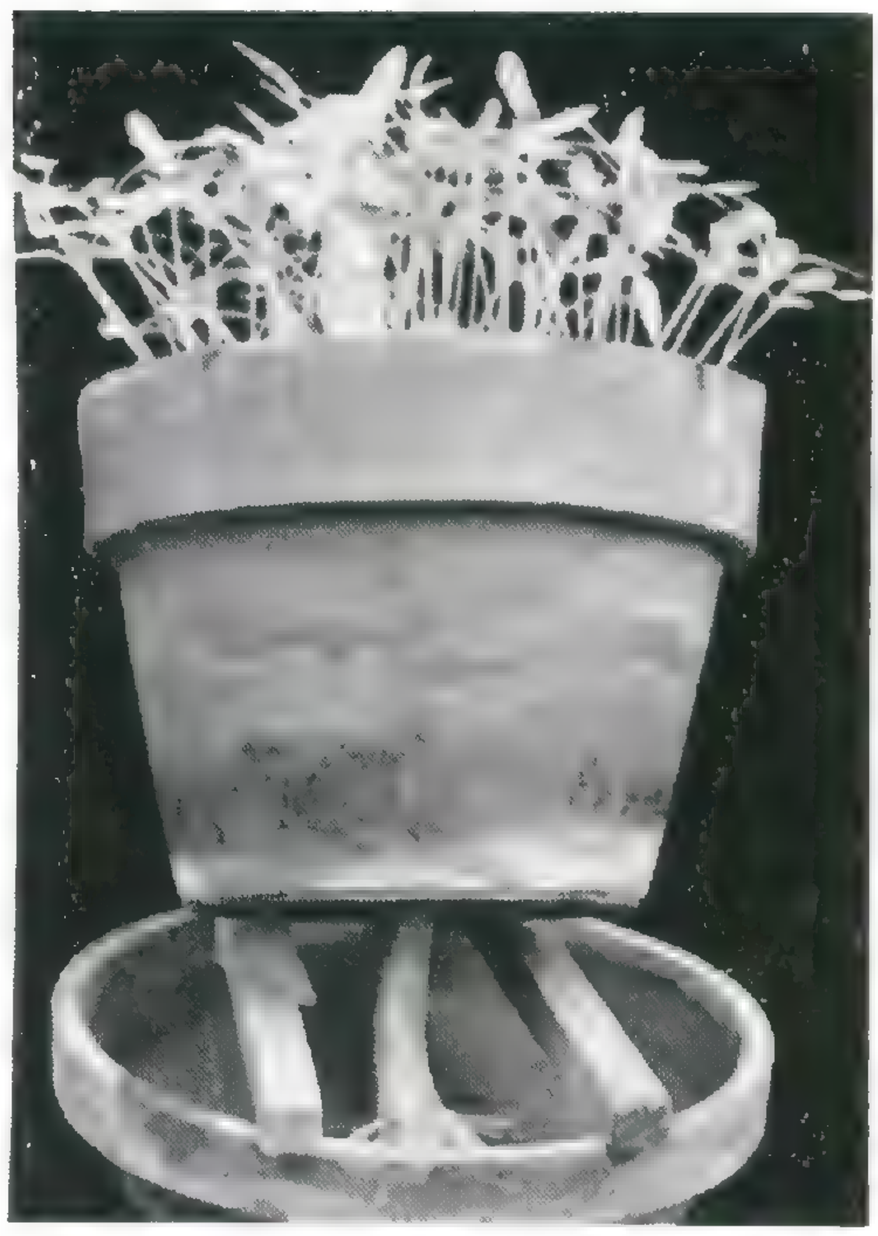
Types and sizes of seeds.—Seeds vary a great deal in size, shape, and the length of time required for germination. If the seeds of petunias and lobelias are covered with more than a quarter of an inch of soil, failure to germinate may be expected, but if barely covered or lightly pressed into the soil more seedlings will come up than can be used. Seeds that are sown on the surface of the soil indoors or in a frame where practically all conditions of soil, moisture, light, and heat can be controlled will germinate readily, but if this were done in the open failure would result.

There is a certain relation between the depth that seeds are sown and their power to germinate. Seeds are frequently sown too deeply. Those covered with much soil do not get the proper amount of air and have the added burden of pushing up the layer of soil above them. Air (oxygen) is absolutely necessary for the germination of seeds. All small seeds should barely be covered, just enough fine soil or sand being passed through the sieve to conceal them. In sieving soil or sand over small seeds the sieve should be held not more than an inch or two above the surface of the soil. If held higher, the particles of sand or soil striking the seeds will cause them to jump in all directions. Some of them will then be on the surface, or some will have a light covering and others a heavy one, resulting in an uneven and many times poor germination. In sowing fine seed the tendency is to make the soil too fine. The finer the particles the more compact the mass of soil will become, and after wetting, such soil will bind and become hard. When fine seeds are sown upon such a surface their delicate roots experience great difficulty in penetrating the hard crust. They generally remain stunted at the surface and finally succumb. Fine seeds sown upon a rough surface are more apt to grow. Larger seeds, such as coreopsis, hollyhocks, asters, and zinnias, may be sown somewhat deeper, being covered with about a quarter of an inch of soil.

Soil medium in which to sow seeds.—Most seeds have been, and probably always will be, sown in soil, since it is the commonest material available and gives good results. The best soil for the purpose is composed of about two parts loam, one part leafmold or peat moss, and one part sand. By loam is meant a soil that contains a liberal amount of vegetable matter in the form of decaying roots, leaves, etc.

Washed and sterilized sand is a good medium in which to sow seeds. Although it lacks any food to sustain the seedlings after they have germinated, this can be supplied by watering the pots once a week with a solution consisting of one teaspoonful each of superphosphate and potassium nitrate dissolved in one gallon of water. Equally good results may be secured from a solution of four to six teaspoonsful of a 4-12-4 commercial

Damping-off disease causing snapdragon seedlings to collapse.



Pan of tomato seedlings tilted to show method of using glass-wick.

Snapdragon seedlings germinating in surface layer of sphagnum.

fertilizer to a gallon of water, this being applied once a week when the seedlings are small and twice a week as they grow larger. Sand dries out rapidly but this can be prevented if a fibre-glass wick is used.

Seedlings can be ruined by the damping-off disease just before or after germinating. The thread-like parasite spreads over the surface of the soil and may destroy a crop of seedlings over night. Because this disease is always associated with a great amount of humidity, seedlings just germinating should not be watered toward evening. A humid condition may also be created if the cover-glass or paper is left on the boxes or pots after the seedlings are up. One of the reasons why sand is so much better than soil for sowing seed is that it does not retain as much moisture, even though it is watered more frequently. Seedlings will also be lost by the damping-off disease if they are crowded. Various precautions should be taken to prevent the spread of the disease. Clean receptacles should always be used; pots should be washed and boxes brushed. Undoubtedly, steam sterilization will help to prevent damping-off, but practically no gardener is equipped to use that method unless he has a steam-pressure cooker. Heating the soil in an oven will kill many disease spores, but the odors will drive the family from the house. Boiling water poured over the surface before sowing the seed will help. This soil must be left to dry for a day or two, as wet soil will puddle and will be difficult to handle. Formaldehyde is a good disinfectant and, in addition to being simple to use, it doesn't disturb the physical condition of the soil. However, care must be taken to avoid spilling any on the skin and not to use it in the house, because the fumes will irritate the eyes and nose unless there is good air movement. Soil should be treated twenty-four hours before it is used, at the rate of a tablespoonful of 40 per cent formaldehyde to an ordinary water bucket of soil. Cover the bucket with paper or a sack to confine the fumes. Dusting the seed with a disinfectant, such as Semesan, before it is sown will reduce to some extent the amount of damping-off.

Sphagnum moss is an excellent sterile medium in which to sow seeds, but when used alone it is harder to handle than soil. It may be combined with soil or sand or used only as a surface dressing. Dry sphagnum must be rubbed through a wire sieve of ¼- or ½-inch mesh. This is not as difficult as it may seem. A tight wad of the moss rubbed over the sieve will pass through quickly, and there is so little danger of scuffing the knuckles that it is hardly necessary to wear a glove. The dry, screened moss must be moistened before it is used. A good way to do this is to place it in a flat, sprinkle it, stir it, and sprinkle a second time. Should it become too wet squeeze it in the hand like a sponge. The moss is then

ready to be mixed with soil or sand or used alone.

Granulated peat is another material which may be added to soil instead of leafmold. It is very dry when purchased and must be moistened before mixing with soil. It also is quite sterile and needs no treatment before being used.

Sowing the seed.—A four-inch pot or a six-inch bulb pan is large enough for almost any kind of seed. Place several pieces of broken crock, concave side down, over the drainage hole. Fill the pot with soil up to the top, level, and firm with a tamper. The soil surface should now be about one-half inch below the rim, which is the proper depth for all except the largest seeds. Good air circulation about the seedlings is secured if the soil surface is near the top of the pot, and this is a great help in combating the damping-off fungi which destroy so many seedlings.

Tear off one corner of the seed packet and by lightly tapping the packet sow the seed evenly over the surface or in rows. Sow the seed too thin rather than too thick, which is a common error. Add sand to some of the soil and use this mixture for covering the seed. Cover small seeds with a thin layer of soil and large seeds to a depth twice their size. A good way to cover the seed evenly is to place the sandy soil in a ⅛-inch mesh sieve, hold the sieve about two inches above the pot and lightly tap it. The flow of soil can be regulated in this way and any unevenness corrected by moving the fingers in the sieve to release additional soil. Gently tamp the soil and then water the pot. Use a can with a fine rose (perforated nozzle) so as not to wash the seed out of the soil. When the water has drained away, water a second time if necessary. Cover the pot with a piece of glass or paper, or both. Very little water need be given until the seeds germinate and yet the surface must never be permitted to dry out. Inspect the soil each morning to see if water is needed. When the seeds begin to germinate the glass or paper should be raised slightly at one side to admit air, and after the seedlings begin to push through, the pot should be uncovered. The close atmosphere under the cover is ideal for the spread of fungous growths, and a great many seedlings will be lost if the cover is left on too long.

Transplanting seedlings.—After the seedlings are up and are sufficiently large to handle they are ready for transplanting. Removing seedlings from their pots should not be postponed too long. Even though the seeds had not been sown thickly the seedlings are always more or less crowded in the pots or flats and should be separated from their neighbors as soon as possible. The majority of seedling plants may be handled with the fingers, either being strong enough to be held by the stem or having a leaf large enough

Transplanted seedlings of snapdragon and columbine. Notice growth of plants in flats compared with those in crowded condition in seed pans.

Lupine

Moonvine

Chipping or filing hard-coated seeds hastens germination.

to act as a handle. Whenever possible a seedling should be held by the leaf, as then there is less danger of crushing the tender plant. The box into which the seedlings are to be transplanted should contain some drainage material and should be filled with light soil. It should then be leveled and tamped in the same manner as when the seeds were sown. The surface should be finished with some finely sifted soil and tamped. If this is not done, especially when small seedlings are to be transplanted, the small lumps of soil will cause much annoyance. If the soil is very dry it should be watered before transplanting the seedlings and then set aside. A box of damp soil that needs no water is to be preferred to one that has been watered an hour previous. Soggy soil clings to the dibber and the fingers.

To remove the seedlings from the seed-pan, with the right hand insert a stick or plant label beneath the roots and gently raise a bunch of seedlings, at the same time grasping them with the left hand. Do not take all of the seedlings from the pan at one time as they dry out very rapidly. Lay them on a piece of paper and bring them to the box of soil. Mark the rows on the surface of the soil with a straight-edged stick. Space the rows in the flat from one and a half to two or three inches apart, depending upon the size of the plants. Also space the plants the same distance in the rows. The size of the seedlings soon after germinating serves as a fair indication of the distance apart to transplant them. With the dibber make a hole in the soil deep enough to receive the roots without crowding. Slightly turn the dibber back and forth as it is withdrawn from the hole to prevent any soil from rolling back. If the seedlings have unusually long taproots, pinch them back halfway. This will do no harm and will cause the plantlet to send out lateral roots. After the seedling is placed in the hole the dibber is again thrust into the soil near the seedling and the soil firmly pushed against the roots. If an air pocket is left at the bottom of the hole the roots cannot come in contact with the soil. Seedlings should be transplanted to about the same depth as they were in the seed box. However, when they are very spindly and have a tendency to shoot up, they should be planted deeper in the hole. There are some kinds of seedlings, the delphinium being an example, in which the heart of the plant is quite low. In transplanting such seedlings one must be careful not to cover the center of the plant, lest it might rot. Again there are large seedlings that produce robust plants (lupines, castor-beans, etc.). These should be immediately set into two- or two and one-half-inch pots.

After the flat is filled with plants it should be watered and placed in the frame or window. If the sun is shining brightly, shade the plants with paper the first and second days. Seedlings that have been crushed or broken in handling will wilt and die.

If the seedlings are transplanted to a pot instead of a box, and this can be done if only a few dozen of a kind are wanted, the surface of the soil should not be more than one-half inch below the top of the pot. Larger seedlings may be set deeper. Seedlings planted in flats will not dry out as rapidly as those in pots, and more can be grown in a given space if planted in rows in flats. If it is intended to leave the seedlings in the flats until time for planting directly into the garden, more space should be allowed in the flats when they are transplanted from the seed-pan.

Seedlings that are to be transplanted to pots should be carefully lifted with a spoon or plant label and should have as much soil adhering to the roots as possible. The plant is held in the center of the pot. Then the soil is added and firmed about the seedling. Just when to water the seedlings after repotting will depend upon weather and soil conditions. If the day is cloudy and the potting soil is moist a day may elapse before watering. If, however, the soil is dry, but this condition could be improved when the soil is mixed, and the day clear and warm, the seedlings will have to be watered soon after potting. If very dry, the pots should be soaked before using, otherwise they will absorb much of the soil moisture. When a plant is reset the root system is disturbed, but if the potting soil is moderately moist new roots will form more quickly than if it is quite wet. It is always a good policy to keep newly potted plants a little on the "dry side" until root development is again active. Wilting may be prevented during this period by spraying the foliage lightly and shading the plants.

When warm weather has arrived and the flower beds are prepared the plants may be taken out of the pots and set in their place. Roots which have become matted due to the length of time in the pots should be loosened before planting. This will break up the distinct ball the roots have been forming and will cause them to strike out in all directions and take hold of the soil in the flower bed. As soon as possible after all the plants have been set in beds they should receive a good watering. The same precautions used when transplanting from boxes to pots must be taken against wilting when planting the seedlings in the flower beds. Cloudy weather is ideal for planting flowers outside. Late afternoon and evening are better than the morning for transplanting, as the plants can revive during the night. Transplanting should not be done on extremely hot and windy days. A good gardener will find ways and means to overcome the difficulties that will at times confront him.

II. Vegetative Propagation

DAVID C. FAIRBURN

Many garden plants are best propagated by vegetative methods, not by seed. Some reproduce naturally by offshoots such as runners, suckers, bulbs, roots, rhizomes and leaves, whereas others are increased artificially by various types of cuttings, layering, and grafting. These methods of propagation are absolutely necessary in order to perpetuate the desirable characteristics of numerous hybrid specimens created by plant breeders. For instance, all the fine varieties of iris, peonies, roses, dahlias and gladiolus do not come true to color, size or shape when raised from seed, but if propagated by division of the clump, root and stem cuttings, or by separation of the bulbs, all of the varietial characters are retained in the propagations. When plants have been so highly specialized by hybridization that they produce no seed, vegetative methods of increase must be adopted. The seedless grape and orange are common examples of this specialization, as well as many ornamentals which are infertile due to the excessive doubleness of the flowers. Furthermore, some plants are so difficult to raise from seed that amateurs can hardly devote the time and effort essential in their culture. Thus for various reasons many ornamental and economic plants are propagated by one of several methods indicated in the following outline, the choice of method being determined by the type of plant, the results desired, the equipment available, etc.

- Stem
  - 1. Cuttings
    - A. Soft-wood
    - B. Half-ripened wood
    - C. Hard or dormant wood
  - 2. Rhizomes
  - 3. Runners
  - 4. Offsets
  - 5. Layers
  - 6. Bulbs, bulbels, bulblets, scales
  - 7. Corms, cormels
  - 8. Tubers
- Root
  - 1. Cuttings
  - 2. Suckers
  - 3. Tuberous roots
- Leaf
  - 1. Viviparous leaves
  - 2. Leaf without petiole
  - 3. Leaf with veins severed
  - 4. Leaf divided into sections
  - 5. Leaf with petiole
  - 6. Leaf-bud cutting
- Entire Plant
  - Division of clump or crown

Of course it is first necessary to decide how a certain plant should be propagated, vegetatively or by seed. Such information can often be obtained

by studying the plant in question, but mere observation is not always reliable as the visible characters do not necessarily reveal the genetic make-up of the individual. In other words, a striking variety of gladiolus may develop a fine lot of seed pods, but it is quite likely that only very few seeds will produce desirable plants. So the presence of seed is often just a detour sign for all except the plant breeder.

As a general rule, plant propagation for the amateur may be summarized as follows: (1) seed only—practically all annuals and biennials, (2) seed and vegetative methods—true species of perennials and some annuals, (3) vegetative methods only—all hybrid varieties of perennials. To this classification there are exceptions, but for the most part vegetative propagation is concerned with the hardy and tender perennials of garden and greenhouse.

1. Propagation by Means of Stems

Cuttings.—A cutting is a piece of root, stem, or leaf which is able to continue growth and establish an entire new individual when detached from the rest of the plant. Propagation by this method is widely practiced commercially because it is a quick and economical way to increase stock. Many perennials supposedly do not respond to such treatment, but there is hardly any doubt that cuttings of all plants could be induced to form roots and shoots if provided with the proper conditions.

Success with cuttings depends largely on the methods of handling, the requirements varying with the different kinds of plants. Usually the cuttings do well if exposed to conditions favorable to the growth of the parent plant, but in certain cases special treatment is necessary, and even with the best of care, failures are apt to occur. The chances of error can be materially reduced if the right kind of plant material and equipment are used.

Plants.—Always select healthy, vigorous plants as stock for cuttings. Those blighted with disease or infested with insects should be avoided unless they are thoroughly cleansed of these parasites before using. Otherwise success is accidental.

Rooting medium.—Soil, peat, sphagnum moss, sand, and water may be used in rooting cuttings. For outdoor work a light sandy loam gives fine results. Peat and sphagnum moss are used to advantage with certain types of cuttings and for layering. Rooting in water is also possible with some plants, but in the majority of cases clean sharp sand of moderately coarse texture is the best material to use. It permits good drainage and aeration, which are beneficial to root formation.

Propagating-pots, cases, benches.—When only a few cuttings are to be

rooted, an eight-inch bulb pan equipped with a small pot for irrigation purposes makes a convenient arrangement. A handful of broken crockery is placed in the bottom of the pan for drainage and the sand filled in around the small pot which has the hole at the base tightly corked. Water gradually seeps out of the small porous clay pot and keeps the sand uniformly moist. This is a very handy outfit for home use. A glass bell-jar placed over the cuttings will protect them from the harmful dry atmosphere present in most dwelling houses.

A shallow box or flat of sand, with a pane of glass on each side and on top to conserve the moisture, makes a fine propagating-case. An aquarium containing several inches of sand and fitted with a glass cover will serve the same purpose, provided the sand is not kept too wet. With such equipment

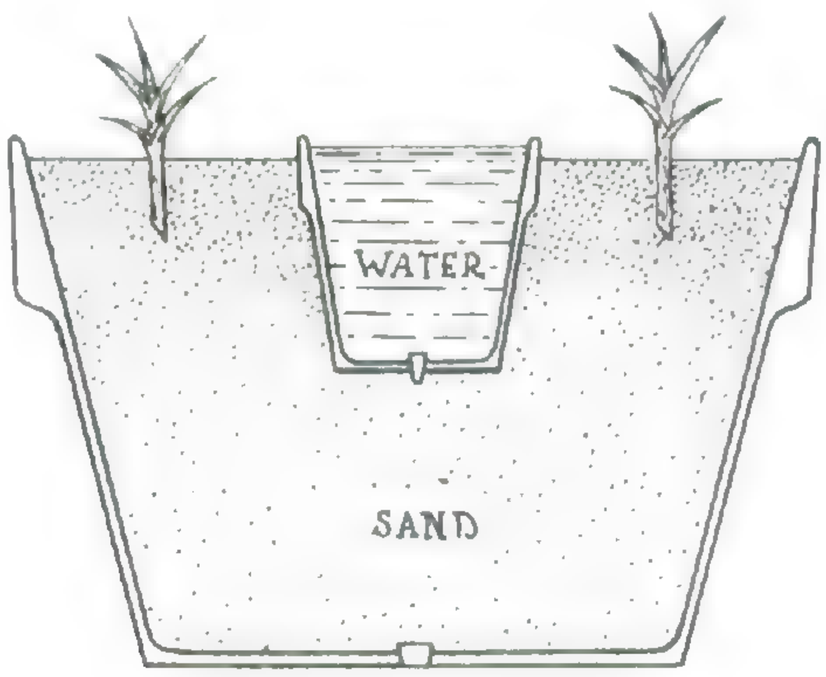


Fig. 2. Propagating-pot.*

one can carry on an interesting form of gardening in the home during the winter months. The propagating-case or pot should be placed where the cuttings can have the benefit of sunlight. Glass-enclosed cases or jars heat up quickly when exposed to direct sunlight, so it is necessary at times to prop open the lids or remove the jars to provide adequate ventilation. Slight bottom-heat from a steam or hot water radiator will stimulate root action. In the greenhouse, propagating benches are used for cuttings. Steam or hot-water pipes are usually placed under the benches to control the temperature of the sand. Some cuttings are almost impossible to root without this bottom-heat.

When a confined moist atmosphere is needed for rooting, a box or frame is placed on top of the bench. Certain kinds of cuttings will not root unless given the protection of a frame where drafts can be avoided as well as variations in moisture and temperature. Bell-jars or any wide-mouthed glass container serve the same purpose on a smaller scale.

*Reproduced from Fairburn's *Plant Propagation for the Garden.* Doubleday, Doran & Co. 1936.

Cuttings of most herbaceous perennials and woody plants are easily rooted outdoors if placed in a sash frame containing a well-drained, light, sandy soil. The frames require shading with lath or something to keep out the direct rays of the sun and prevent excessive evaporation during the summer.

Temperature, moisture, light.—The proper rooting temperature for different kinds of cuttings varies from 50° to 80° F. or over. For the majority of plants, however, about 65° to 70° F. is ideal. Root growth should accompany or precede top growth, and for this reason bottom-heat is applied to keep the sand five to ten degrees warmer than the air. In frames outdoors this extra heat may be obtained from the soil or by several inches of fermenting manure placed under the rooting medium. The latest and best source of heat is electricity. Cables are stretched under the sand and a constant temperature maintained by thermostatic control.

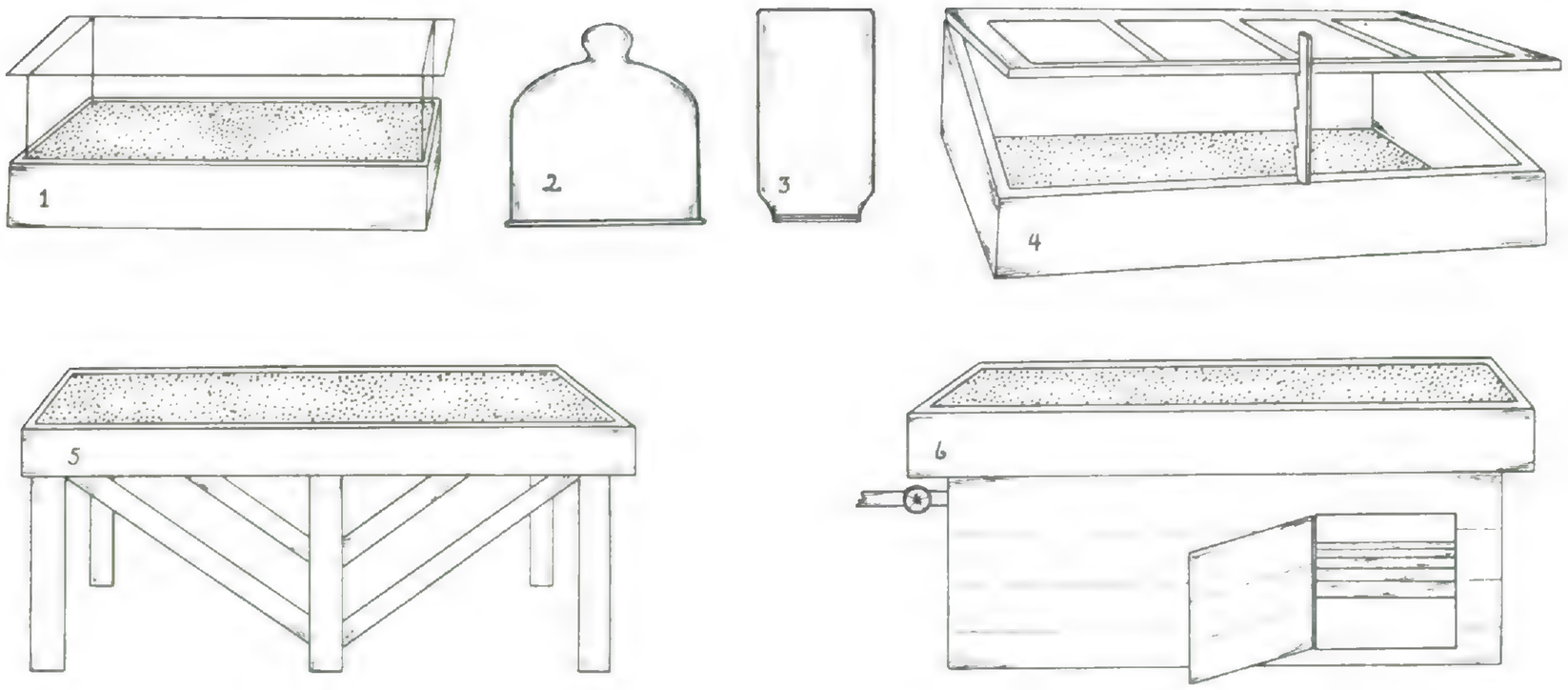
Humidity is a very important factor in plant propagation and must be regulated to suit the kind of cuttings being handled. For example, cuttings of cacti and other succulents require a fairly dry environment. Too much moisture in the air or sand causes them to rot in a hurry. On the other hand, cuttings of many large-leaved conservatory plants demand the close humid atmosphere of a "Wardian Case" to root. If kept too dry, they collapse. For most of the common garden and greenhouse stock, moderately moist conditions are recommended. The sand should never be soggy nor dry. Sprinkle the foliage occasionally to keep the leaves firm.

When cuttings are first placed in the sand, they should be shaded from strong sunlight to avoid wilting, but as roots begin to form, more light can be admitted until finally they have established enough feeding roots to stand full sunlight. Keeping the cuttings in a shady place after the roots are well developed is a mistake. Without sufficient light, photosynthesis is retarded, causing the young plants to become spindly and weak. Fresh air is also essential, but avoid drafts.

Tools, accessories.—Other equipment useful in plant propagation is shown in pl. 30, fig. 1. A sharp knife to trim off the cuttings, a tamping block to press down the sand, a straight-edge to mark off the rows if benches or cases are used, a dibble to make holes in the sand for the cuttings, wooden labels, a soft-lead pencil, a sprinkling can, newspaper for temporary shade, and a fair amount of patience are about all one needs.

To avoid casualties due to disease fungi which often destroy cuttings, observe the following suggestions carefully:

1. Use sterilized equipment whenever possible.
2. Always use clean sand.
3. Keep the sand just moderately moist, not soaking-wet.



(From Fairburn's *Plant Propagation*)

Fig. 3. Equipment for Vegetative Propagation

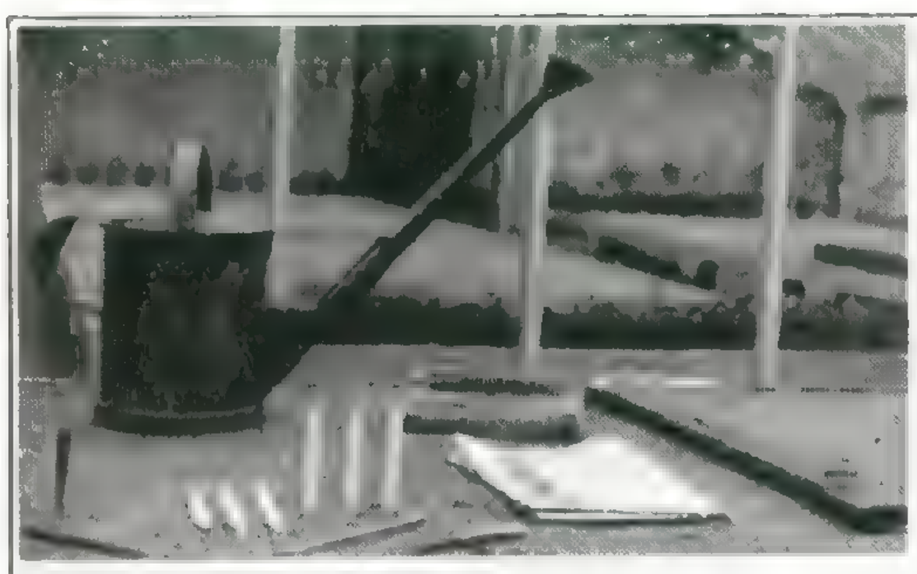
1. Propagating box with glass enclosure. 2. Glass bell jar. 3. Fruit jar. 4. Propagating case (Wardian case). 5. Propagating bench without bottom heat. 6. Propagating bench with bottom heat supplied by steam or hot water.

4. Fresh air and air circulation are important.
5. Do not over-crowd the cuttings.
6. The temperature should be about 65°–75° F.
7. Cuttings that have started to root need lots of direct sunlight.
8. Remove all dead or deseased cuttings from the sand.

Soft-wood cuttings.—Stem cuttings may be separated into three general groups: (1) soft-wood, (2) half-ripened wood, (3) hard or dormant wood. To outline the various details of stem propagation by soft or green-wood cuttings which are commonly called "slips," let us consider the common geranium (pls. 30 and 31).

The stock plant from which the cuttings are to be taken should be healthy, vigorous, and well branched. The slips are made from wood that is brittle and snaps off readily when bent. Shoots of young succulent wood rot quickly in the sand, while old fibrous stems are always slow to root and produce inferior plants. Terminal or tip cuttings are generally preferred. The main shoots of some plants, such as the large-leaved rhododendrons which have considerable pith, are usually removed to force the development of lateral growths that have a greater proportion of wood and root more readily. Old plants can be "headed back" this way to get new lateral shoots for cuttings. Slips about four inches long are cut off the stock plant with a sharp knife. The leaves are removed from one or two nodes at the base of the cutting, but do not reduce the leaf area of the top unless it is excessively large and inconvenient. Leaves manufacture food which is necessary for the development of a new root system. If too many leaves are cut off, the plant is liable to suffer from malnutrition, and in this weakened condition is more susceptible to damping-off fungi. The cuttings will naturally shed any excess foliage, so do not reduce the tops unless they are inconvenient or have a tendency to wilt badly.

All flower buds should be removed and the stem cut off clean just below the basal node. Geranium cuttings do better if lightly sprinkled with water and exposed to the air for several hours before being placed in the sand. This permits the wounded cells to heal over and discourages rot. To prevent wilting, most soft-wood cuttings are kept in a pail of water or wet newspaper until placed in the sand. Cuttings that have a milky sap are best dried for a few hours, as with geraniums. The base of the cutting is inserted in holes or trenches made in the sand with a dibble, one or more nodes being covered to insure good rooting. Some propagators advocate pressing the slips into the sand without the aid of a dibble, but unless one is very careful the plant tissues are apt to be injured. The sand should be firmed gently around the stem to avoid air pockets and the cuttings thoroughly



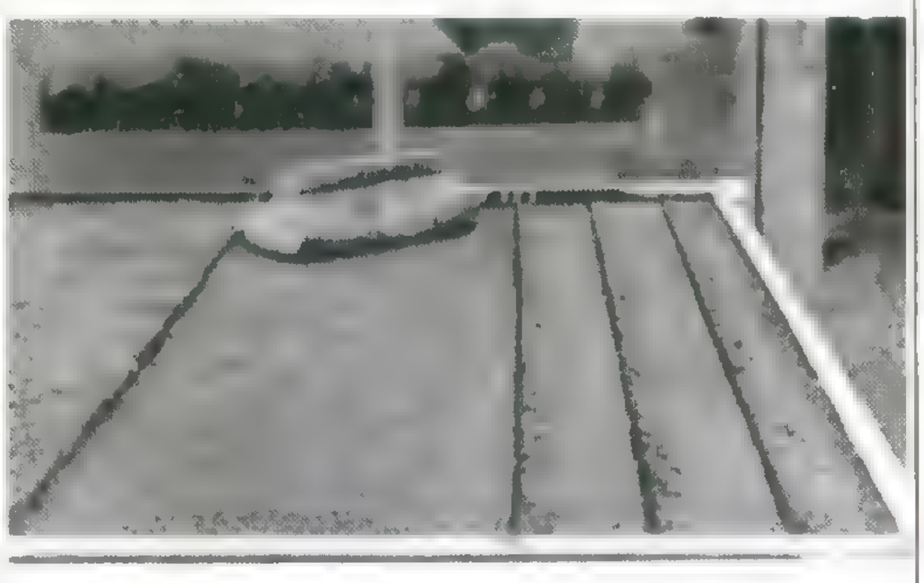
1. USEFUL EQUIPMENT FOR PROPAGATION

2. STOCK PLANT

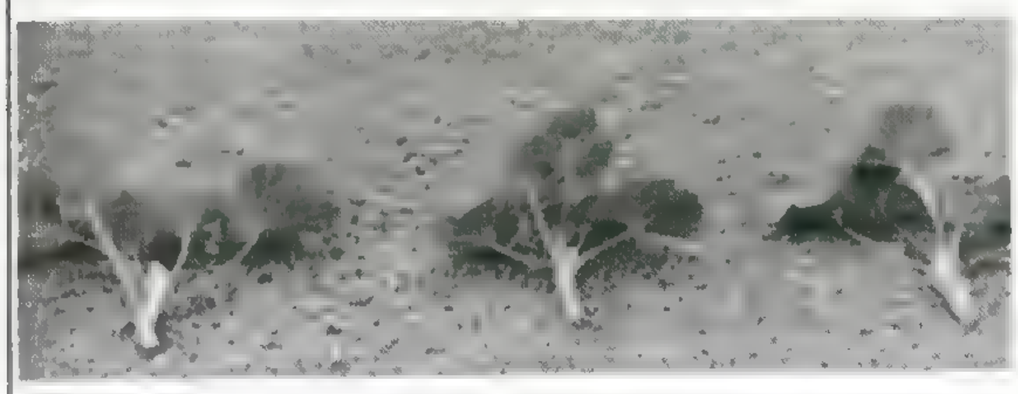
3. TAKING THE CUTTING

4. CUTTING REMOVED

5. STOCK PLANT PRUNED



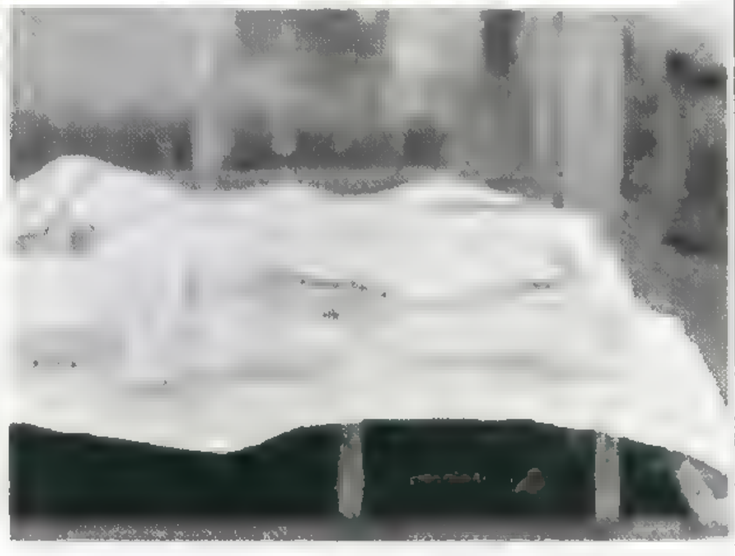
6. SAND TAMPED, ROWS MARKED OFF



7. CUTTINGS TRIMMED, READY TO GO IN SAND

8. CUTTING FIRMED IN SAND

9. CUTTINGS SHOULD BE THOROUGHLY WATERED



10. SHADE FOR SEVERAL DAYS

watered. Shade with newspaper, cheese-cloth, or lath for about one week, and then expose to full sunlight. Keep the sand barely moist.

A temperature of 70°–75° is favorable to rooting, and if possible use mild bottom-heat. In about three to four weeks the cuttings will form roots at least one-half inch long. The young plants should then be removed from the sand and potted up in a heavy loam soil containing an abundance of organic matter (leafmold, manure, compost, or peat). Water the plants well and shade for a few days until the roots become established.

House plants, as well as a large portion of the garden and greenhouse stock, are generally increased by soft-wood cuttings. A few examples are shown on pl. 31, fig. 6. Cuttings root differently at various times of the year. Tender plants can be propagated to advantage during fall and winter when the sunlight is not too intense and bottom-heat is available. Hardy herbaceous perennials are easily increased by this method in the spring when the plants have new shoots seven or eight inches tall. Select the stems which are firm, not too soft, and always leave a few buds on the stock plant for future growth. Many cuttings can also be rooted in summer if shaded from direct sunlight and watered properly.

Plants Increased by Soft-wood Cuttings

ANNUALS AND TENDER PERENNIALS*

Abutilon—Flowering Maple
Acalypha—Chenille Plant
Ageratum—Floss-flower
Alternanthera
Antirrhinum—Snapdragon
Ardisia
Begonia semperflorens
Beloperone—Shrimp Plant
Cacti
Codiaeum—Croton
Coleus
Conservatory plants—many kinds
Crassula
Cuphea—Cigar Plant
Dahlia
Euphorbia—Poinsettia
Ficus elastica—Rubber Plant
Fuchsia—Lady's Ear-drops
Gardenia
Heliotropium—Heliotrope
Hibiscus—Rose-mallow
Impatiens
Ipomoea—Sweet-potato
Iresine—Blood-leaf
Lantana
Lobelia
Mesembryanthemum
Oplismenus—Variegated Grass
Pelargonium—Geranium
Philodendron
Pilea—Artillery Plant
Plumbago capensis—Leadwort
Salvia—Sage
Selaginella
Stevia
Strobilanthes
Succulents—many kinds
Swainsona
Tradescantia—Wandering Jew
Verbenas—garden varieties
Vinca major—Periwinkle
Zebrina pendula—Purple Wandering Jew

*All cultural data listed are specific for Missouri.

Hundreds of hardy perennials can be propagated by soft-wood cuttings. A few of the more common ones are:

HARDY HERBACEOUS PERENNIALS

Alyssum saxatile—Golden-tuft
Amsonia
Arabis—Rock-cress
Arenaria—Sandwort
Asclepias tuberosa—Butterfly-weed
Aster
Aubrietia—Purple Rock-cress
Boltonia
Campanula—Bellflower
Caryopteris
Centaurea Cyanus—Cornflower
Ceratostigma plumbaginoides—Blue Leadwort
Chrysanthemum
Clematis
Delphinium—Larkspur
Dianthus—Pink
Eupatorium coelestinum—Mist-flower
Gaillardia—Blanket-flower
Gypsophila—Baby's-breath
Helenium
Helianthus—Sunflower
Heliopsis—Orange Sunflower
Hesperis—Sweet Rocket
Hydrangea
Iberis—Evergreen Candytuft
Ivy
Lobelia
Lychnis—Campion
Lythrum—Loosestrife
Mentha—Mint
Monarda—Horse-mint
Myosotis—Forget-me-not
Penstemon—Beard-tongue
Phlox
Ranunculus—Buttercup
Salvia—Sage
Saponaria—Soapwort
Sedum—Stonecrop
Silene—Catchfly
Solidago—Goldenrod
Teucrium—Germander
Tradescantia—Spiderwort
Veronica—Speedwell

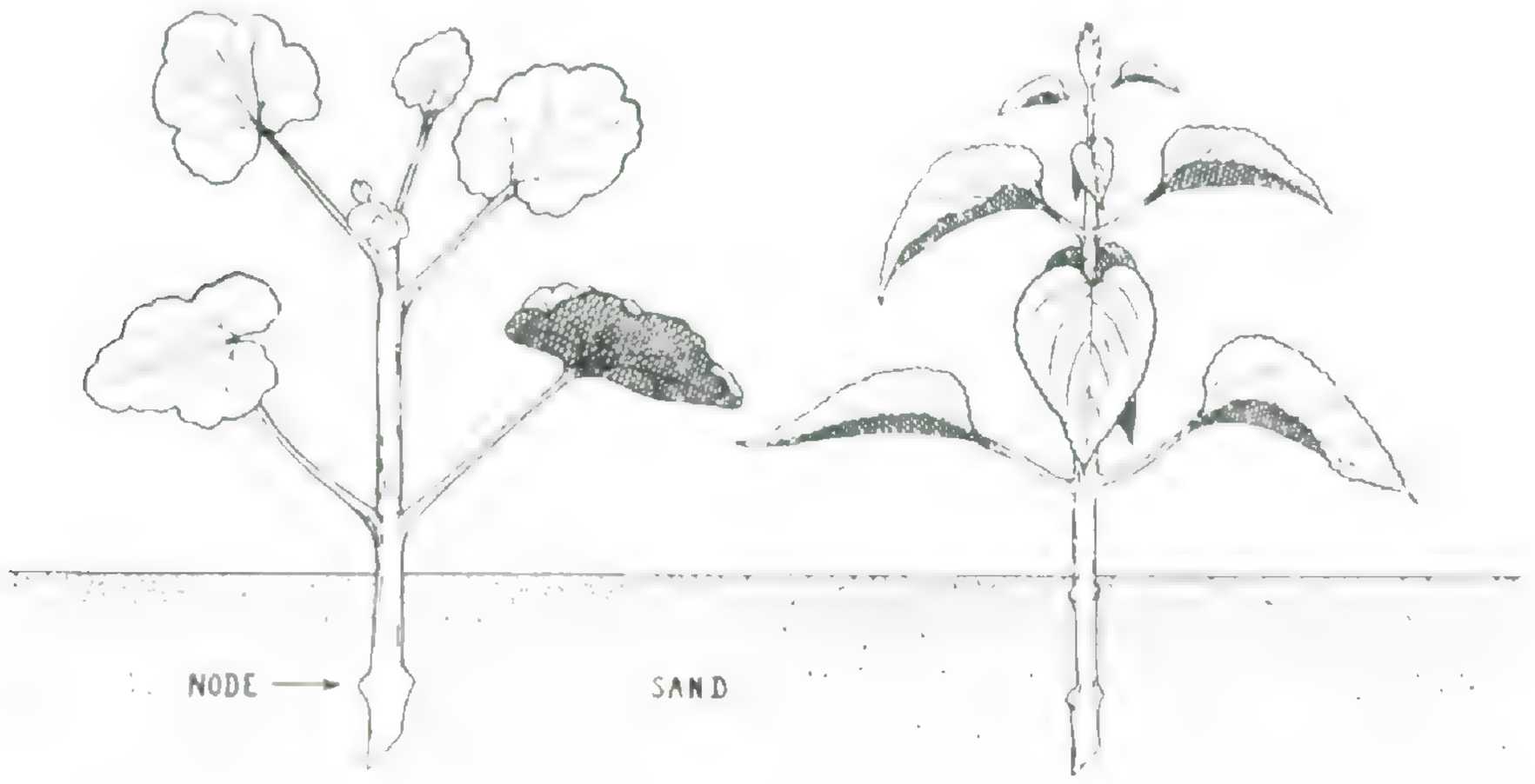


Fig. 4. Cuttings placed in sand.

Summer cuttings of woody plants.—During the summer, two types of cuttings can be made from ornamental shrubs and other woody plants: (1) soft-wood from young shoots which have a texture similar to the stems of a geranium, (2) half-ripened wood that has nearly completed growth. Cuttings made from young green shoots are handled in the same manner as "slips," except that a frame or Wardian case is practically necessary for rooting.

The half-ripened wood cuttings, with leaves attached, quickly strike root and develop into well established little plants for setting out the follow-

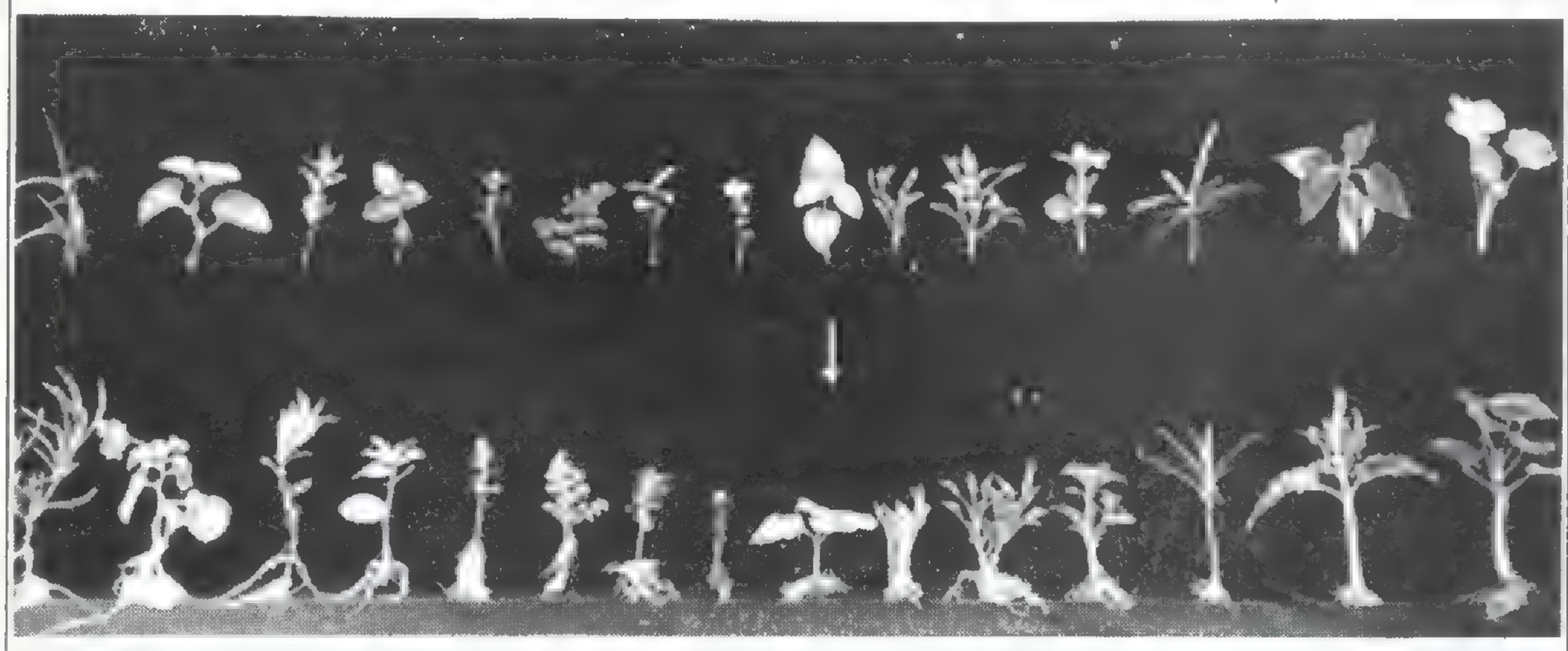
1. REMOVING ROOTED CUTTING FROM SAND

2. UNROOTED AND ROOTED CUTTING

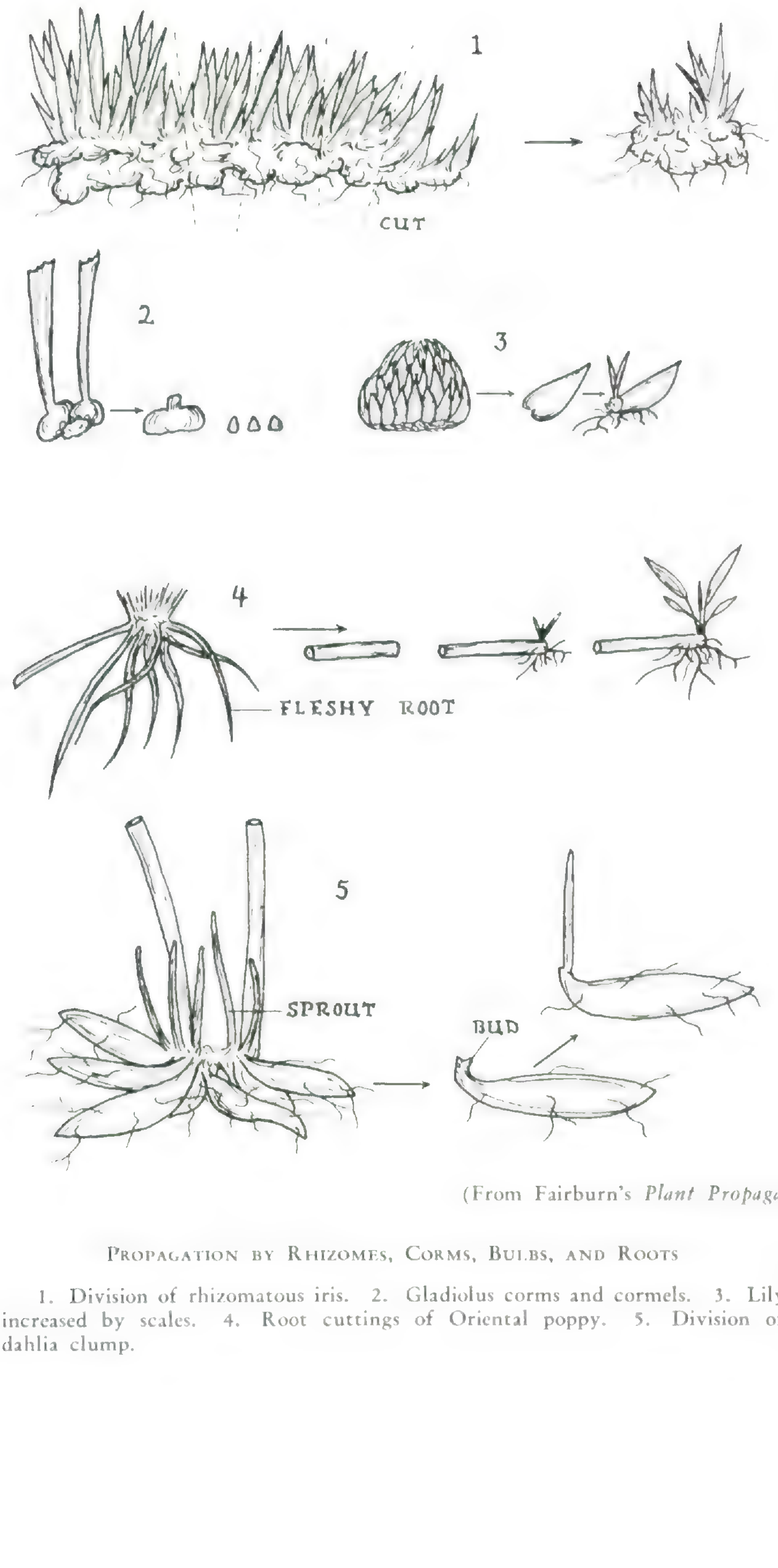
3. POTTING THE YOUNG PLANT

4. WATER, SHADE SEVERAL DAYS

5. STOCK PLANT, OFFSPRING



6. SOFT-WOOD CUTTINGS OF VARIOUS PLANTS



(From Fairburn's *Plant Propagation*)

PROPAGATION BY RHIZOMES, CORMS, BULBS, AND ROOTS

1. Division of rhizomatous iris. 2. Gladiolus corms and cormels. 3. Lily increased by scales. 4. Root cuttings of Oriental poppy. 5. Division of dahlia clump.

ing spring. The cuttings may be taken from May to September, the time depending on when the plant makes its new growth. A shaded sash frame outdoors or in the greenhouse is ideal for this purpose, but if only a few cuttings are to be rooted, a small box with a glass cover is satisfactory. Inverted fruit jars are also effective.

The cuttings should be about six inches long and just brittle enough to snap off when bent double. The tip ends of the shoots are commonly used, but in some cases other parts of the stem will also root. The leaves are removed from two or three nodes at the base of the cutting and a clean cut made just below the basal node. The lower portion is then buried in sand several inches and the cuttings watered as usual. The frame should be covered tightly with sash to maintain a close humid atmosphere. An occasional spraying with water (in the morning) will help to prevent the foliage from wilting. Do not keep the sand very wet. The cuttings will generally root in four to six weeks, then they can be transplanted to nursery beds or placed in flats of soil and kept in frames. The young plants are benefited by a protective mulch during the winter or they may be held over in cold-frames to avoid alternate freezing and thawing. In spring the plants can be moved to permanent quarters.

Summer cuttings can be made of the following shrubs:

Abelia—Bush-arbutus
Acanthopanax—Five-leaf Aralia
Aronia—Chokeberry
Azalea
Berberis—Barberry
Buddleia—Butterfly-bush
Buxus—Boxwood
Calycanthus—Sweet-shrub
Chionanthus—Fringe-tree
Cotoneaster—Rock-spray
Cytisus—Broom
Deutzia
Exochorda—Pearl-bush
Forsythia—Golden-bell
Hibiscus syriacus—Shrub-althea
Hydrangea
Kerria
Kolkwitzia—Beauty-bush
Ligustrum—Privet
Lonicera—Honeysuckle
Mahonia—Holly-grape
Philadelphus—Mock-orange
Rhodotypos—Jetbead
Spiraea
Symphoricarpos—Snowberry
Viburnum
Vitex—Chaste-tree
Weigela

Hard-wood cuttings.—Many shrubs, trees, and vines are propagated by this method. The cuttings are taken in the fall or during the winter when the wood of the previous season's growth is fully ripened and dormant. It is an advantage to take the cuttings in autumn as they will callus and often root before planting out in the spring. Some hard-wood cuttings can be planted outdoors in the fall in ordinary soil and will callus without difficulty if given slight winter protection. As a rule, however, the dormant shoots are cut up into pieces about six inches long and tied in convenient bundles with the tops all one way. The cuts are best made at or near the basal nodes and the lower buds rubbed off to prevent suckering when planted. The bundles are stored in boxes of moist sand, soil, or peat in a cool cellar. By

the time spring arrives, the lower ends of the cuttings will have formed prominent calluses. The same results can be obtained outdoors by burying the bundles in sandy soil below the frost line. A mulch over the top of the soil will retard deep freezing.

In spring the callused cuttings are planted upright in the nursery row a few inches apart. The planting depth varies according to the nature of the cutting, but it is customary to leave approximately one-third of the stem above the soil, thus permitting one or several buds to develop into new shoots. In the fall the young plants can be moved as desired.

Short pieces of woody stem having only one eye or bud can frequently be used as cuttings. They should be started under glass with bottom-heat.

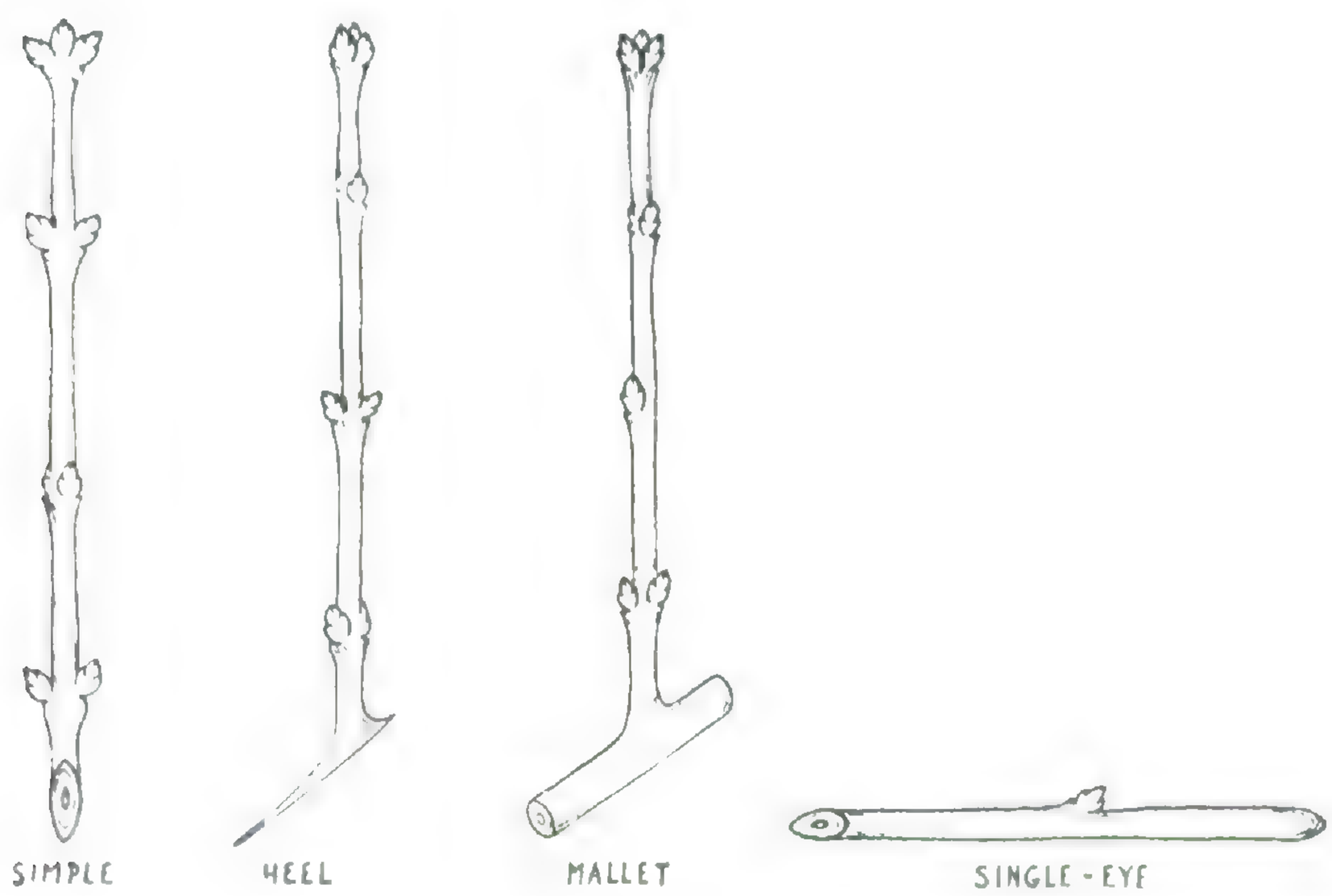


Fig. 5. Types of hard-wood cuttings.

The small pieces of stem are imbedded horizontally, one inch deep, in sand, the bud facing upward. When roots and shoots form, the young plants are potted up in soil and later set out in the field.

Various types of hard-wood cuttings are illustrated in figure 5. The heel and mallet types are useful with plants such as evergreens which root very slowly. Cuttings of evergreens are handled in the same way as summer cuttings except that mature wood of the past season's growth is taken in fall after frost.

The following plants, as well as most of the shrubs mentioned in the foregoing list, may be propagated by hard-wood cuttings:

Akebia
Ampelopsis—Virginia Creeper
Campsis—Trumpet Creeper
Catalpa
Cephalanthus occidentalis—Buttonbush
Chaenomeles—Flowering Quince
Crataegus—Hawthorn
Elaeagnus—Russian Olive
Euonymus—Burning-bush
Nerium—Oleander
Physocarpus—Ninebark
Populus—Poplar
Pyracantha—Firethorn
Rhamnus—Buckthorn
Rhus—Sumac, Smoke-tree
Ribes—Currant
Sambucus—Elder
Staphylea—Bladder-nut
Tamarix—Tamarisk
Vitis—Grape
Wisteria

Rhizomes, runners, offsets, layers.—Some plants are propagated naturally and artificially by various kinds of stems which have become radically modified from the typical upright leafy forms. Many stems are weak and slender and lie prostrate on the ground where they frequently strike root, while others are climbers and support themselves on suitable objects. In certain cases they are partly or wholly subterranean, often being mistaken for roots. When stems normally contact the soil, they produce young plants of their own accord, but occasionally the process can be hastened by artificial methods.

Rhizomes or rootstocks.—A rhizome is an underground stem which generally bears roots, shoots, and leaves. Some rhizomes, such as those of certain Iris, are only partly subterranean, while others may penetrate rather deeply into the soil, as exemplified by the numerous slender rootstalks of plumbago *(Ceratostigma plumbaginoides)*. A rhizome is distinguished from roots by the presence of nodes, a true root having no such structures.

The German or common iris is propagated by division of the rhizomes (pl. 32, fig. 1). A large clump is dug up and divided into a number of small pieces, each having two or three sprouts for new growth. These fragments, when planted separately in the garden, soon develop into sizable specimens. When the rhizomes are slender and bear no prominent shoots, they are cut up into short pieces and rooted in sand before planting outdoors. The cuttings are placed horizontally and covered with about one inch of sand or set upright with the lower portions embedded an inch or more in the sand. After roots and shoots have formed the young plants are potted up in soil and later transferred to the garden.

Unfortunately, two very pestiferous weeds, quack grass and bindweed (wild morning-glory), are propagated by rhizomes. Cultivation severs the rootstocks, and a new vigorous crop soon appears from these cuttings. For this reason they are very difficult to eradicate.

The following plants are propagated from rhizomes:

Achimenes
Agropyron—Quack Grass
Asarum—Wild Ginger
Aspidistra—Cast-iron Plant
Canna
Convallaria majalis—Lily-of-the-valley
Convolvulus—Bindweed
Ferns—certain kinds
Helleborus—Hellebore
Holcus halepensis—Johnson Grass
Hosta—Plantain Lily
Iris—rhizomatous types
Narthecium—Bog Asphodel
Nymphaea—Hardy Water-lilies
Podophyllum—May-apple
Polygonatum—Solomon's-seal
Primula Seiboldi
Rheum Rhaponticum—Rhubarb
Sanguinaria—Bloodroot
Smilacina—False Solomon's-seal
Trillium—Wake-robin
Trollius—Globe-flower

Runners.—In some plants the stems are in the form of runners which creep along the surface of the ground and strike root at the nodes, producing new plants. Independence from the parent plant is established by the death or severance of the connecting stem after the offspring has developed roots and shoots. This method of increase permits the young plant to receive nourishment from the parent until it is able to shift for itself. Familiar examples of plants that propagate by means of runners are:

Fragaria—Strawberry
Nephrolepis—Boston Fern
Saxifraga sarmentosa—Strawberry Saxifrage

Offsets.—Many plants produce small rosettes or leafy shoots near the base of the parent plant. These offsets are sometimes attached to the parent by a short stem (pl. 34, fig. 5), but in other cases they cling directly to the main stem. When the offsets are borne next to the surface of the soil, it is an easy matter for them to strike root and eventually become independent. Offsets that do not contact the soil can be removed and placed in moist sand where rooting will occur in a short time.

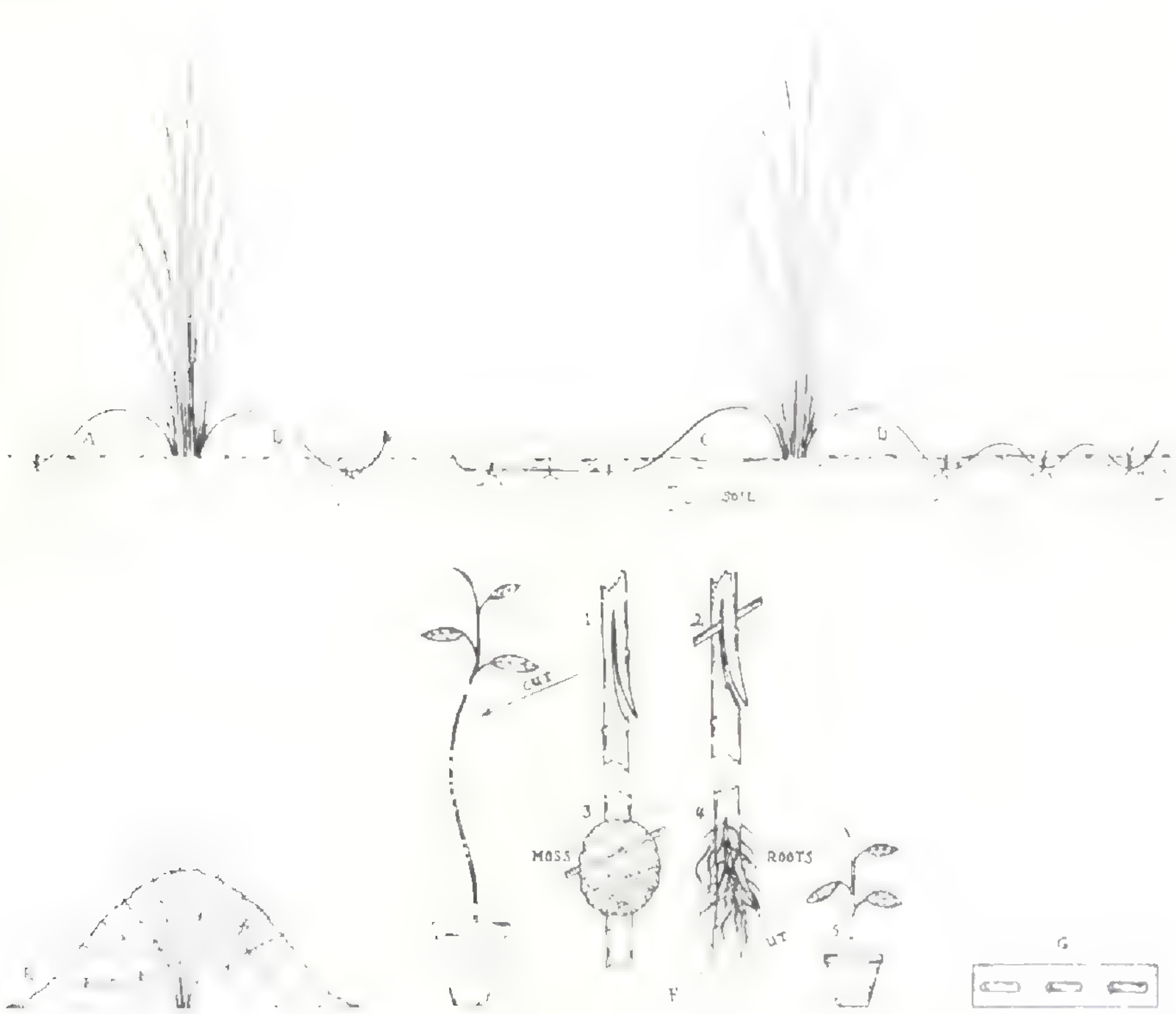
The following plants increase by offsets:

Ananas sativus—Pineapple
Anthericum—St. Bernard Lily
Billbergia
Cotyledon
Echeveria
Eichhornia crassipes—Water-hyacinth
Marica
Pandanus—Screw-pine
Phoenix dactylifera—Date Palm
Pistia Stratiotes—Water-lettuce
Sempervivum—Houseleek
Tillandsia

Layers.—Sometimes the stems or branches come in contact with the soil and take root at the nodes while still attached to the parent. Many plants do this unaided, while others require the gardener's assistance. It is one of the simplest and most dependable methods of propagation and is known as layering. It is often successful when cuttings fail, being especially useful with hard-wood material. For example, some rhododendrons are almost impossible from cuttings but respond well to layering.

There are several different types of layering. To make a *simple* layer, a branch is bent over to the ground and partly covered with sand or soil, the tip being left exposed. The branch is held in place by the weight of the material covering it or by some type of anchor. That portion of the branch

which is to be buried should have all the leaves removed unless they are sufficiently long-stemmed to extend above the surface. With woody stems a short cut or notch is made at each node that is to be covered, to stimulate root formation. The cut should be propped open with a match or toothpick. When the layer is well rooted, connection with the parent is severed, and the young plant removed. Layering outdoors is usually done in the spring and summer. Embed the young growing shoots in a light sandy soil and keep the soil moist at all times. In the greenhouse, plants can be layered any time during the year, using sand, peat, or soil as a rooting medium.



(From Fairburn's *Plant Propagation*)

Fig. 6. Types of Layering

A. Tip. B. Simple. C. Continuous. D. Serpentine. E. Mound. F. Chinese or air. G. Woody stem cut into small sections and layered in sand or moss.

Tip layering is commonly used with black raspberries and similar plants. The canes are bent over in late summer and the tips anchored in the soil. Roots and shoots soon appear at the tips, forming new plants which are cut from the supporting canes in the fall or spring and planted separately. Tip layering is illustrated in fig. 6, A.

Vines with long flexible stems are often propagated by *serpentine layers* (fig. 6, D). Alternate sections of a single stem are imbedded in the sand

or soil. Roots appear on each submerged scallop and a large number of plants are obtained.

In *continuous* layering, practically the entire branch except the tip is covered. This type is used with a limited number of vines and shrubs, since many plants will not develop shoots from buds which are covered with sand or soil. Ivy, willow and high-bush cranberry are easily propagated in this manner (fig. 6, C, and fig. 7).

Mound layers are used to advantage with low-growing plants which have stems that are too stiff to bend satisfactorily. Gooseberries lend themselves readily to mound layering (fig. 6, E). The plants are pruned back severely to encourage branching at the base. Sandy soil is then mounded up around the new shoots which strike root at the nodes. The young plants develop rather slowly, often requiring two years to establish a good root system.

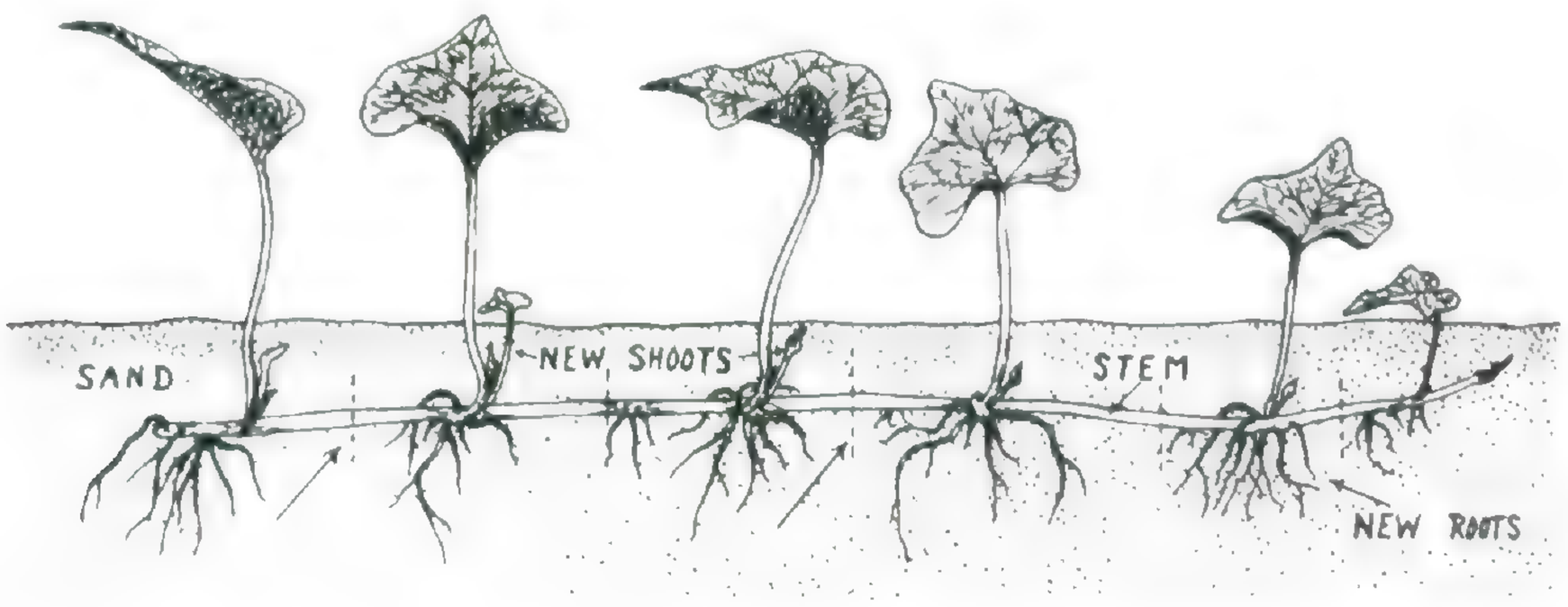


Fig. 7. Propagation by continuous layering.

Other plants propagated by this method are:

Azalea
Calycanthus—Sweet-shrub
Cotoneaster
Cydonia—Quince
Spiraea "Anthony Waterer"
Hydrangea

Greenhouse plants such as rubber plant, Croton and Dracaena that have rigid woody stems are often increased by Chinese or *air layering* (fig. 6, F). A slanting upward cut is made through one or more nodes on the stem and the cut propped open with a toothpick. A ball of damp sphagnum moss is then tied securely around the stem where the cut has been made. If the moss is kept moist and the plant exposed to a warm temperature, roots will soon form. The stem should then be cut off just below the ball of moss and the rooted section with moss intact potted up in soil to form a new plant. This is one way to reduce "leggy" or spindly plants to a desirable size. Another method is to cut the woody stems into short pieces and place them horizontally in damp moss or sand. Each piece will take root and form a new plant (fig. 6, G). Bottom-heat encourages rooting.

Bulbs, corms, tubers.—Many plants are propagated by bulbs, bulbels, bulb-scales, bulblets, corms, cormels, and tubers. These structures are simply modified stems and leaves which occur mostly underground. They contain large quantities of stored plant food, and under favorable conditions of moisture and temperature new plants are formed from dormant buds.

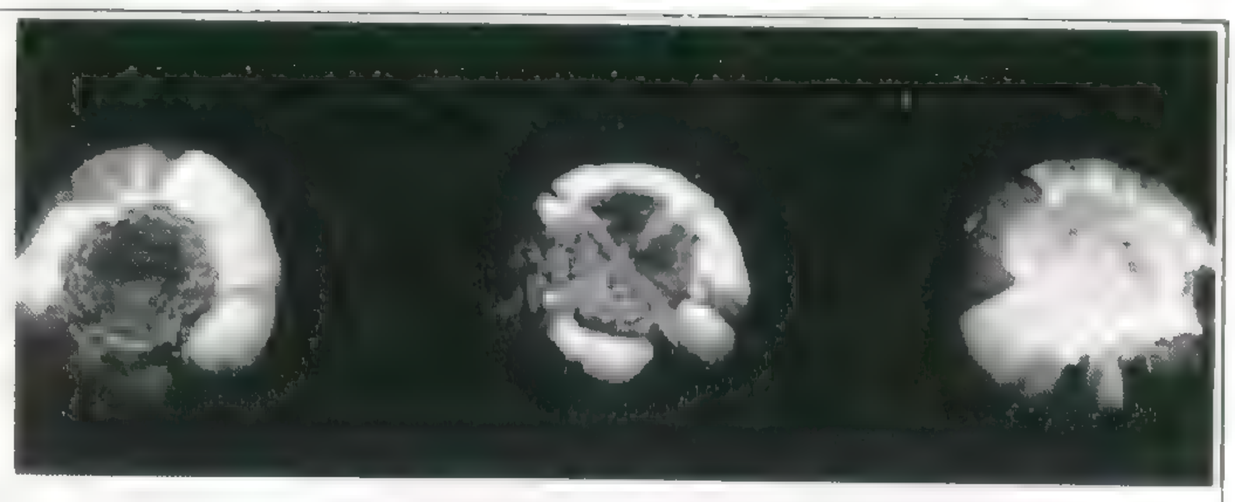
A *bulb* is a rounded underground structure composed mostly of fleshy scale-like leaves. There are two general types of bulbs: (1) tunicated, such as the onion, hyacinth, and tulip, which are composed of close-fitting layers of leaf tissue covered with a dry husk, (2) scaly, illustrated by the lily, which is made up of thick, loose, overlapping scales.

Bulbs are increased by natural separation. A mother bulb will produce one or more large bulbs or a number of small bulbels. If the bulbs are large enough, they will bloom within one year, but the small bulbels usually require several years to reach blooming size. When the mother bulb is dug, the bulbels are removed and replanted separately in pots, flats, or beds until they are large enough to produce flowers. Hardy bulbs, such as those of narcissus which increase rapidly, should be transplanted frequently to avoid crowding and subsequent non-flowering.

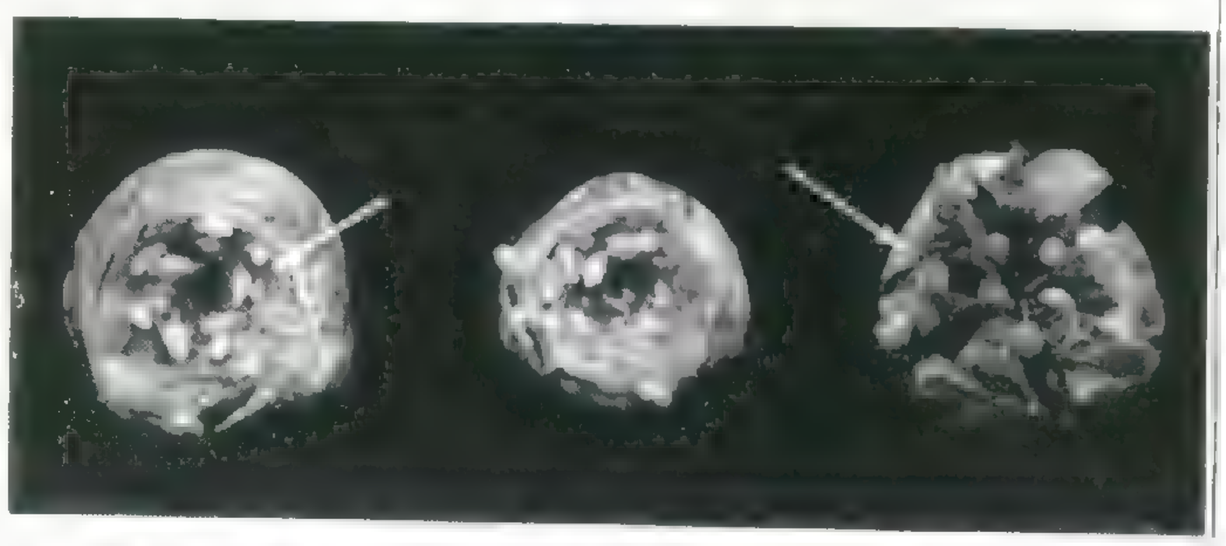
Hyacinths are propagated artificially by notching or scooping the bulbs when they are dug in spring and early summer (pl. 33, figs. 2 and 3). Making transverse cuts through the base of the bulb is known as notching. These cuts must not be too deep nor too shallow for good results. Any one not experienced in the art of making the notches will undoubtedly have some casualties. Scooping is also a delicate operation. The entire basal section of the bulb is removed in such a way that all the layers of scales are slightly severed. The wounded bulbs are dusted with slacked lime and placed, bottom up, in a moist chamber where the temperature can be maintained at 80° F. Within a few weeks small bulbels will start to form on the notched and scooped portions. The bulbs should remain in storage during summer and planted (with the young bulbels attached) outdoors in the fall. The bulbels then grow to maturity, being separated and replanted in special nursery beds the second year. Scooped bulbs produce more bulbels than notched ones, but they are small and require four to five years to reach flowering size. Notched bulbs form fairly large bulbels and flower in three to four years.

Lily bulbs are propagated by separation and are easily raised from the fleshy *scales* (pl. 33, fig. 4). Shortly after the bulbs have flowered, the scales are removed and placed in damp sphagnum moss in a warm greenhouse. Small bulbels will soon develop at the bases of the scales, and will flower in about three years. Another method is to plant the scales two inches deep in soil outdoors during the summer and leave them undisturbed

1. BULBLETS ON TIGER LILY



2. HYACINTH BULBS NOTCHED AND SCOOPED



3. BULBELS FORMING ON SCOOPED AND NOTCHED BULBS

4. LILIES INCREASE BY SCALES AND BULBELS

5. PROPAGATION OF GLADIOLUS, AMARYLLIS, LILY

until they flower some three years later.

A few plants produce bulblets on the stems in the axils of the leaves or in the flower cluster (pl. 33, fig. 1). When ripe these small bulblets drop off or are removed by hand and planted. Their culture is the same as for bulbels. In one to three years they will usually flower. Some of the plants increased by bulblets are:

Allium—Onion
Begonia Evansiana—Hardy Begonia
Ferns—certain kinds
Lilium (bulbiferum, Sargentiae, sulphureum, tigrinum)—Lily

The Madonna and several other lilies can be propagated from the lower part of the flower stem. After the flower has been cut off, the base of the stem is pulled out of the bulb and layered in sand. Small bulbs will arise from the prostrate stem and will flower in two or more years. Culture the same as for bulbels.

A *corm* is a rounded, fleshy, underground base of a stem. It is composed mostly of stem tissue, being solid like a potato, whereas a bulb consists mainly of leaf tissue and when cut open crosswise shows a number of concentric scaly rings. The gladiolus is a familiar plant that produces corms. Each year one or several new corms of flowering size are formed on top of the old mother corm, which deteriorates at the end of the growing season (pl. 33, fig. 5). When the plant is dug in the fall, these new corms are separated and planted individually the following spring. Large corms may be cut into sections like a seed potato to produce more plants. *Cormels* are also formed at the base of the new corm. These cormels should be stored in fairly moist sand or soil until spring and then planted in rows like seed. In one to three years they will develop to blooming size.

The following plants propagate by corms:

Calochortus
Crocus
Cyclamen
Gladiolus
Ixia
Sparaxis
Tigridia
Tritonia
Watsonia

Some plants, such as the common Irish potato and the Jerusalem artichoke, reproduce by *tubers*, which are thickened underground stems bearing conspicuous buds. These tubers may be planted whole or cut up into several pieces, each piece having at least one healthy bud. Seed potatoes are usually divided into three or four sections which are planted separately. Each section produces a new plant.

2. Propagation by Means of Roots

Cuttings.—Plants with thick fleshy roots can usually be propagated without difficulty from root cuttings. In certain cases, however, variega-

tions are not transmitted by this method. The roots are cut up into pieces two or more inches long and planted horizontally, about one inch deep, in sand, moss, or soil. If bottom-heat is applied, new roots and shoots soon appear on the cuttings. Both hardy and tender plants can be propagated by this method in the greenhouse, but usually root cuttings of hardy stock are placed in pots or flats of sandy soil in the cold-frame over winter. In spring the small plants are well established and ready to be set out in the garden.

Root cuttings of tender plants do well in the greenhouse if exposed to a moderately cool temperature. The cuttings can be made at any time of the year. Some thrive better if placed in the sand vertically with the ends slightly protruding above the surface, but when in doubt use the prostrate method.

The list of plants that can be propagated by root cuttings is of course extensive. A few examples are as follows:

Aesculus parviflora—Dwarf Buckeye
Ailanthus—Tree-of-heaven
Amelanchier—Shadbush
Anchusa—Bugloss
Bocconia—Plume Poppy
Bouvardia
Campsis—Trumpet Creeper
Caragana—Pea-shrub
Cirsium arvense—Canada Thistle
Chaenomeles—Flowering Quince
Dicentra spectabilis—Bleeding-heart
Euphorbia—Spurge
Gypsophila—Baby's-breath
Halesia—Silver-bell
Papaver orientale—Oriental Poppy
Phlox—hardy type
Radicula Armoracia—Horseradish
Rhus—Sumac
Robinia—Locust
Rosa—Rose
Rubus—Raspberry, Blackberry
Sambucus—Elder
Staphylea—Bladder-nut
Taraxacum—Dandelion
Verbascum—Mullein
Wisteria
Xanthoceras
Yucca—Adam's-needle
Zanthoxylum americanum—Prickly Ash

Suckers.—Plants which produce suckers from the roots can also be readily increased by root cuttings. Willow, poplar, black locust, and sassafras propagate naturally by suckers, the shoots arising at various points along the roots. These adventitious growths can be separated from the parent and planted individually.

Tuberous roots.—The enlarged, fleshy storage roots of plants, such as the dahlia, sweet-potato, tuberous begonia, and caladium, are used for propagating purposes. Most tuberous roots (the dahlia excepted) have the ability to produce adventitious buds and form new plants. Merely plant the root in moist sand or soil and wait for developments. Sweet-potatoes sprout easily in a jar of water.

Dahlia clumps which have been stored in dry peat over winter should be divided in the spring when the buds begin to show at the base of the stem. The tuberous roots must be separated carefully in order that there be at least one bud to each division, otherwise no shoots will develop from

1. LEAF CUTTINGS OF SANSEVIERIA

2. GASTERIA LEAF CUTTING

3. VIVIPAROUS LEAVES OF BRYOPHYLLUM

4. DIVISION OF VARIEGATED SANSEVIERIA

5. OFFSETS OF ANTHERICUM

the root when it is planted in the garden. Dahlia roots started in sand in the greenhouse about the latter part of April will form numerous shoots which can be used as cuttings (pl. 32, fig. 5).

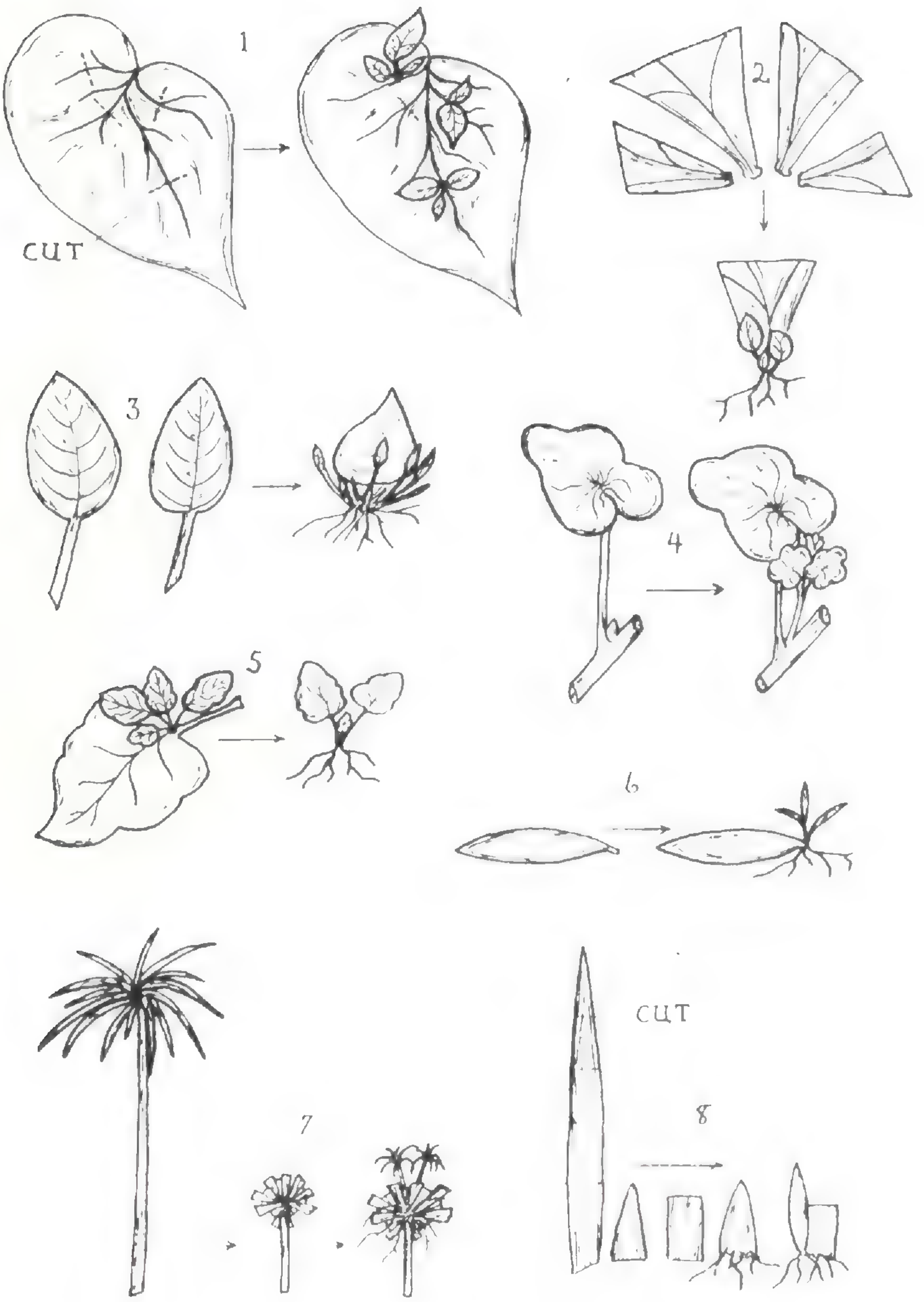
3. Propagation by Means of Leaves

In addition to propagation by stems and roots, many plants have the ability to produce entire new individuals from leaves. This process may occur naturally as in the case of viviparous leaves, or artificially by various types of leaf cuttings.

Viviparous leaves.—Certain kinds of water-ferns, water-lilies, bryophyllums, and *Tolmiea Menziesii* develop young plants naturally on their leaves (pl. 34, fig. 3, and pl. 35, fig. 5). In due time the young plants will detach themselves from the parent leaf and fall to the ground or float away on the water to establish an independent plant. Thus a large plant may become surrounded with a host of offspring like a mother hen with a brood of chicks. In the garden and greenhouse, we usually assist nature by removing the plantlets and potting them up in soil.

Cuttings.—Plants with thick fleshy leaves and petioles (leaf stems) containing sufficient reserve food can generally be propagated by some form of leaf cutting. An *entire* leaf of Bryophyllum placed right side up on moist sand will quickly form a small plantlet at most every notch on the leaf (pl. 34, fig. 3). A leaf of Rex Begonia treated likewise will send forth a number of sprouts from the base of the leaf where all the veins intersect and also from the end of the petiole. Another method is to *sever the veins* of the Rex Begonia leaf in various places. When such a leaf is placed in close contact with moist sand and bottom-heat applied, a new plant should arise from each wound (pl. 35, fig. 1). Rex Begonias are also reproduced by cutting the leaves into *sections*, each section retaining a portion of the fleshy base of the leaf. If these pieces are placed upright in the sand, new shoots and roots will soon appear (pl. 35, fig. 2). The confined atmosphere of a Wardian case or a bell-jar and slight bottom-heat are essential for success with all leaf cuttings of Rex Begonias.

Succulent plants, such as Kalanchoë, Byrnesia, Echeveria, and some sedums, are very easily propagated from leaf cuttings. The fleshy leaves are carefully detached from the parent plant and placed on moist sand. Only the base should be covered with sand, the rest of the leaf remaining exposed to the light. The young plant originates from the latent bud at the base of the leaf. When taking the leaves from the parent plant be careful not to wound them, as they are very subject to rot. Avoid excess moisture. These plants are adapted to rather dry conditions, and to keep



(From Fairburn's *Plant Propagation*)

Propagation by Leaves

1. Leaf of Rex Begonia with veins cut. 2. Rex Begonia leaf cut into sections. 3. Leaf cuttings of African violet. 4. Leaf-bud cutting of geranium. 5. Viviparous leaf of Tolmiea. 6. Leaf cuttings of Byrnesia. 7. Leaf cuttings of Cyperus. 8. Leaf cuttings of Sansevieria.

the sand saturated with water is to invite failure.

The leaves of some plants must have the *petioles attached* in order to strike root (pl. 35, fig. 3). The cuttings are placed vertically in the sand with the petioles buried one or two inches. Young shoots and roots develop from the callus formed on the ends of the petioles. Plants propagated by this method are:

Begonia semperflorens—Ever-blooming Begonia
Gesneria
Gloxinia
Hoya—Wax Plant
Peperomia
Saintpaulia—African Violet
Streptocarpus—Cape Primrose

With *Cyperus alternifolius* (Umbrella Plant) an entirely different type of propagation is necessary. The stem is cut off a few inches below the head of leaves which is pruned to a convenient length. The cutting is then placed in the sand deep enough to cover the entire head, leaving only the tips of the leaves exposed. Roots and shoots arise from the buds in the axils of the leaves, not from the stem as with most cuttings. When potting up the young plant, remove the old original leaves (pl. 35, fig. 7).

Another odd type of leaf cutting is that used for propagating Sansevieria (Bowstring Hemp). The long leathery leaves are cut into pieces several inches in length and the basal ends inserted vertically in the sand, leaving about one-half of the cutting exposed. Roots and shoots develop from adventitious buds formed at the base of the cutting (pl. 34, fig. 1). Avoid excess moisture with these succulent plants. Strangely enough, the yellow variegations of S. *trifasciata* var. *Laurentii* are not transmitted through leaf cuttings. To preserve these variegations the plant must be increased by division of the clump (pl. 34, fig. 4).

A *leaf-bud* cutting includes the leaf, the petiole, the bud in the axil of the leaf, and a portion of the main stem (pl. 35, fig. 4). Roots develop from the "heel" and shoots from the axillary bud. Geraniums, *Begonia semperflorens*, Rhododendrons, Acalypha, and Chrysanthemum are easily reproduced in this manner. It is a good way to get a large increase from a limited amount of stock.

4. Propagation by Division

Plants which form a series of stems from a large crown or those which spread readily by suckers and offsets, making large clumps, are effectively propagated by division (pl. 32, fig. 1). The old plant is dug up or knocked out of the pot and separated into small sections, each having roots and shoots. Plants that make a rampant growth are usually divided every year to keep them in bounds and to avoid crowding. This is especially true with vigorous plants in small rock gardens and flower borders. The following plants usually need frequent division:

Achillea—Yarrow
Artemisia vulgaris—Mugwort
Aster—hardy types
Boltonia
Campanula—Bellflower
Centaurea Cyanus—Cornflower
Cerastium tomentosum—Snow-in-summer
Ceratostigma plumbaginoides—Blue Leadwort
Chrysanthemum—hardy types
Dianthus—Pink
Doronicum—Leopard's-bane
Euphorbia—Spurge
Helianthus—Sunflower
Oenothera—Evening Primrose
Penstemon—Beardtongue
Phlox—hardy types
Ranunculus—Buttercup
Sedum—Stone crop
Solidago—Goldenrod
Thalictrum—Meadow-rue
Veronica—Speedwell

Division and replanting of most garden material is usually done in early fall so that normal growth proceeds uninterrupted in spring. The following perennials are rather slow growing and are generally divided about every five years:

Alyssum saxatile—Golden-tuft
Aquilegia—Columbine
Astilbe
Delphinium—Larkspur
Dicentra spectabilis—Bleeding-heart
Echinacea—Coneflower
Hemerocallis—Day-lily
Hosta—Plantain-lily
Iris
Liatris—Blazing Star
Linum—Flax
Phlox

Peonies should be divided about every seven years. Greenhouse plants, such as ferns, orchids, asparagus, violets, etc., are readily increased by division. Shrubs that have a tendency to spread can also be separated when necessary. This is best done in late fall when the plants are dormant.

Of course to appreciate how fascinating plant propagation really is, one has to bolster up a discussion of this sort with actual experience. After these proposed methods have all been tried, there is still another very important subject to consider, namely, grafting, but that is a story all by itself and hardly falls within the scope of the present article.

For several years scientists have been experimenting with special growth-promoting chemicals to stimulate rooting of cuttings, especially the more difficult types. The results of these investigations can be summarized as follows:

1. Soft-wood cuttings that root easily may or may not be benefited by chemical treatment, depending of course on the kind of plant used.

2. Half-ripened or green-wood cuttings of shrubs, vines, etc., sometimes root better with the chemicals, but certain kinds of cuttings give no response with or without.

3. A limited number of hard-wood cuttings respond favorably to the treatment. Some resist all efforts to make them form roots.

So when using these widely publicized root stimulants, it is wise not to think all your troubles are over. Even fortified with a bottle of vitamin B_1, there is no reason to expect roots to form on a broom-handle.

NOTES

Ex-Sgt. Gerald B. Ownbey, Washington University Fellow in Botany during 1940-42, has recently been discharged from the Army and has resumed his research work at the Garden toward a doctor's degree.

Among the groups visiting the Garden library and herbarium recently were: the students in biology of the Pattonville High School, Pattonville, Mo., under the leadersihp of their teacher, Mr. M. C. Shauver; and the members of the Little Gardens Club, of Clayton, Mo.

The November number (Vol. 32, No. 4) of the ANNALS OF THE MISSOURI BOTANICAL GARDEN was issued during the month, with contents as follows: The Yucca plant, *Yucca filamentosa*, and the Yucca moth, *Tegeticula (Pronuba) yuccasella* Riley: an ecologico-behavior study, Phil. Rau; A revision of the Central American species of Smilacina, Ralph W. Emons; The *Clematis Fremontii* var. *Rieblii* population in the Ozarks, Ralph O. Erickson.

Recent visitors to the Garden include Mr. Grail O. Fernwood, of the New York Botanical Garden; Mr. Thomas A. Macres, of Cornell University and the Paragon Greenhouses, Patchouge, Long Island; Miss Jean Nicholson, Research Assistant, McKee Jungle Gardens, Vero Beach, Fla.; Miss Maxine Kaiser, of St. Paul, Minn.; Mr. Rouhollah Rahmani, of the Dept. of Agr., Tehran, Iran, recently a student at the University of California, Los Angeles; Mr. Robert Scully, orchid grower.

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

The city Garden comprises 75 acres, where about 12,000 species of plants are grown, both out of doors and under glass. It is open every day in the year except New Year's Day and Christmas; week days, 8:00 a. m. until sunset; Sundays, 10:00 a. m. until sunset. The greenhouses are closed every day at 5:00 p. m.

The main entrance to the Garden is at Tower Grove and Flora Place, on the Sarah car line (No. 42). The Tower Grove bus (No. 21), direct from downtown, passes within three blocks of the main entrance.

MISSOURI BOTANICAL GARDEN BULLETIN

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Volume XXXIII December, 1945 Number 10

Cover: Blooming wistaria tree in foreground, barren wistaria vine in background.

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SOME FACTS ABOUT THE GARDEN

The Missouri Botanical Garden was opened to the public by Mr. Henry Shaw about 1860. From that date until his death in 1889 it was maintained under his personal direction. Although popularly known as "Shaw's Garden" the name Missouri Botanical Garden was chosen by Mr. Shaw and he definitely indicated that he wished it called by that name. The Garden passed at his death into the hands of a Board of Trustees, designated in Mr. Shaw's will, and the Board so constituted, exclusive of certain ex-officio members, is self-perpetuating. By a further provision of the will the immediate direction of the Garden is vested in a Director, appointed by the Board. The Garden receives no support from city or state but is maintained almost exclusively from the estate left by Henry Shaw. Since 1939 many Garden Clubs and interested individuals have contributed to a "Friends of the Garden Fund" which is used in developing the new Arboretum, located at Gray Summit, Mo. The Arboretum (1) serves as a source of plants, trees and shrubs for the city Garden; (2) affords areas for gradually establishing a pinetum, a wild-flower reservation and various other features on a scale not possible in the city; (3) provides greenhouses for some 20,000 orchid plants.

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WISTARIA VINE

Though the house has been vacant for seven years, this wistaria continues to bloom without care.

Missouri Botanical Garden Bulletin

Vol. XXXIII DECEMBER, 1945 No. 10

WISTARIA

PAUL A. KOHL

When a sturdy, hardy, and long-lived vine is needed in the garden, first choice may be accorded to the ever-popular wistaria. It is a beautiful plant when it blooms in spring, and during the summer it will cover a large area with heavy, but graceful foliage. It will bloom almost every year, and only occasionally will the flower buds be injured by a severe winter or a late freeze in April. A wistaria is not a suitable vine for a light wooden trellis, unless carefully trained, but is good for a pergola, a rustic arbor, an iron fence, or any other substantial support. By careful pruning each year it is possible to restrict a wistaria to a given area. It is the neglected vine which twists around spouts, roofs, or trellis-work, and in time either loosens or crushes its support. The main pruning is best done during the dormant season when the canes can be traced. Summer pruning in June is necessary to shorten exceptionally rampant runners. If only three or four main canes are permitted to grow in the first few years after the vine is planted, and these are trained to the support, there will be no twisted mass of runners which seldom can be separated.

A young, vigorous wistaria about two years old is the best type to plant. Old vines have only a few heavy roots, which are difficult to dig, and will not recover from the shock of transplanting for many years. A wistaria should be planted out during the dormant period, from October to April. A pot plant, however, may be planted at any time. A rich soil will produce prolific growth and will delay the flowering of the vine, while a lean soil will retard the growth but will hasten the blooming. A little well-rotted manure may be used when the hole is prepared, but concentrated fertilizers should be avoided. If the soil is heavy clay it should be lightened with sand. The swollen portion of the stem of grafted vines is the place where the stock and scion have united, and this should be planted six inches deep. Since a wistaria is frequently planted near a foundation or at the base of a pillar, a depression should be left around the plant for frequent watering during the first year.

Good varietal forms of the Chinese and Japanese wistarias are increased by layering or grafting, and the plants so propagated are superior to seedlings. Some seedlings begin blooming in a few years, but others do not mature for ten or more years. The impression prevails that a grafted wistaria will bloom soon after planting because the scion was selected from a flowering plant. Grafted plants vary in this respect, just as do seedlings. Some plants mature early, while others will not produce flowers until after many years. One can only speculate as to the cause for this tardiness of bloom. It may be soil, location, variety, or age. Two methods of "shock" treatment are suggested to force a backward wistaria into bloom. One method restricts the root growth in May by severing the large roots about

Flowering spurs on a tree wistaria

three feet from the base of the plant. In the other method many of the thin canes are removed in the spring, and the laterals are shortened to about six eyes in June to induce the formation of flower buds. Shortening of the laterals does help, but it can become an arduous task and is not recommended for a large vine. Patience for several more years will usually be rewarded by an abundance of bloom once the plant has become mature. The cover illustration shows a fine tree wistaria in bloom, but a few feet away stands a good grafted vine, now ten years old, which has never bloomed. The lack of flowers on the vine cannot be attributed to location or soil, but probably to the fact that the tree wistaria is much older than the vine.

Two oriental species of wistaria are commonly grown. The first to bloom in the spring is *Wistaria sinensis*, the Chinese wistaria, of which there are blue and white varieties. The Japanese *W. floribunda* blooms a little later, and has blue, white or pink varieties. There are also varieties with long clusters of flowers, but these are seldom planted here. Two other wistarias are listed by some nurserymen, the native *Wistaria frutescens*, which has short flower clusters, and the silky *Wistaria venusta*.

A standard or tree wistaria is a fine plant for the garden and requires very little care. Every June it should be pruned to retain its shape, but in doing so as many of the flowering spurs as possible should be retained. Any long canes which develop later in the summer may be shortened in August or after the leaves have fallen. The little care given a tree wistaria is well repaid in the profusion of bloom during the last two weeks of April.

SOME FUNGUS DISEASES AND INSECTS OF EVERGREENS*

AUGUST P. BEILMANN

In the Middle West most of the conifers—if they grow at all—are rarely bothered by insects or diseases. With so few native conifers, there is no local population of bugs ready to attack. As to diseases, all of the conifers in this locality have been introduced, and since nursery inspection is on a nation-wide basis the plants we obtain usually have a clean bill of health. In time, when coniferous plantings are so extensive that the same species can be found scattered over many square miles, a varied and comprehensive spray program may be as necessary here as in the East.

There are, however, a few diseases and some insects that are bothersome. Chief among the diseases are several kinds of rusts which may be of major importance in some years. The firs, particularly the Momi Fir *(Abies firma)*, may be severely injured by a fungus which causes a die-back of the new growth. Some specimens of White Fir *(Abies concolor)* are also stunted by a similar disease reported to be caused by the fungus *Rehmielkopsis bohemica*. Pruning and burning the infected branches is suggested as a control, and Bordeaux mixture applied in the early spring may be helpful.

The pines are attacked by a Sphaeropsis tip blight which destroys the new growth as far down as the first node. Here again pruning and burning are important control measures, and the Bordeaux spray may be of value. There are, in addition, a great number of leaf rusts found on pines. Many of these have not been identified, and many do little harm except in a very

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* This article deals with the coniferous evergreens, that is, the pines, firs, spruces, and their allies, rather than the broad-leaved evergreens.

cool wet spring. If these rusts belong to the genus Coleosporium, they have as alternate hosts a great number of garden plants ranging from asters to currants and gooseberries. Elimination of the alternate hosts will successfully control the disease. However, garden plants should not be destroyed unless the rust has been identified and the damage is serious.

The life histories of many of the rusts are imperfectly known, but some of them spend part of their lives on pines, firs, and junipers, and the remainder on some wild flower or garden plant. In the Middle West, perhaps the best-known disease of this type is the cedar apple rust. It attacks the fruits and the foliage of some varieties of cultivated apples, and it produces the very conspicuous gall on cedar in early spring. It does small harm to the juniper aside from disfigurement, but it can, and often does, cause a great deal of harm to the commercial apple. It may also attack the hawthorn *(Crataegus* sp.*)* and the quince. The juniper has one more serious disease—a twig and branch blight which may kill the entire plant or just certain branches. It appears to be more severe on the Savin Juniper *(Juniperus Sabina)* and its many varieties. The best control is the planting of other and less susceptible species.

The most important insect attacking conifers in the Middle West is the bag worm *(Thyridopteryx ephemeraformis)*. The larvae of this insect feeds on the foliage of evergreens and may strip the tree while safely enclosed in the woven bag. At the end of the season the bag, which is also used as a pupal coccoon, may cause considerable damage. The silken strands by which it is attached to the branches are so strong that if they happen to girdle a twig, particularly a terminal shoot, the twig is killed. The bag worm attacks other trees as well as conifers, but it can be effectively controlled if arsenate of lead sprays are applied by May 15.

Perhaps the second most serious pest is the red spider mite—the only close relative of the spider which is injurious to these plants. This mite spins a web on the surface of the needles or leaves, under which it spends most of the time while sucking juices from the foliage. A strong stream of water sprayed on the foliage may be of help, but sometimes this merely scatters the pest throughout the plantation. The best control is a contact spray such as pyrethrum. Sulphur sprays have been recommended but in the temperature of a middle-western summer they often kill trees faster than red spider.

Short-leaf Pines in our vicinity are frequently attacked when young by a moth whose larvae bore in the terminal twig and cause its death. If these attacks are repeated annually, the tree may be stunted and the terminal shoot will begin to take on some of the characters of a "witches-broom."

This does not exhaust the list of either insect pests or diseases, nor does it include every conifer which may be injured in the course of its life span. Most of the evergreens not listed are not seriously affected at the present time. The Canadian Hemlock *(Tsuga canadensis)*, for instance, has been singularly free of all troubles. The same is true of Douglas Fir *(Pseudotsuga taxifolia)* and, of course, all other Junipers except the Savin. Except for the bag worm, which is easily controlled, the Spruce, if the trees are at all hardy, is not bothered with disease or pests.

There is another serious pest of conifers which cannot be controlled by spraying, and this is the sapsucker *(Sphyrapicus varius)*, which is one of the small woodpeckers. This bird may single out a particular tree for its attention, and feed on the soft inner bark until the trunk has been riddled in a checker-board pattern. He may completely girdle a tree or, working only on one side, cause the death of a large patch of bark. The injury may be confined to a single tree, but in the course of twenty years a coniferous planting may be considerably damaged. We can offer no control in this case except perhaps the judicious use of a shot gun.

As a general thing, a tree is less likely to be seriously injured by disease if it is in prime condition, and a rapidly growing tree, well fed, will more quickly recover and replace the leaves lost through insect feeding. A species or variety which is not entirely at home in this locality will be the first to die if it becomes host for either insects or diseases. Most of the pines, spruces, arbor-vitae, in fact, all the conifers, require good soil and good care in our region. Fertilization, mulching, and irrigation are essential practices for all but a few of the more commonly grown kinds. In short, the story boils down to this—in the Middle West, at least at the present time, neither fungus diseases nor insects are likely to limit the selection of coniferous trees for ornamental use; eventually, as the population of such trees increases, insects and diseases may be of greater importance.

THE SHORT-LEAF PINE

AUGUST P. BEILMANN

While many species of pines from all over the world have been grown successfully at the Arboretum, the only native Missouri species, *Pinus echinata*, has never cooperated well with us. Thousands of seeds and seedlings have been planted, but until recently it was represented by only a small group of unhappy trees. Assuming that this pine has some of the characteristics of another well-known Missouri character, the mule, and that it could not be pushed from the south to the north unless it chose to go that way, we have been carefully searching for the northernmost station of this tree.

Fig. 1. Short-leaf Pine on Gus Patke farm.

Pinus echinata is usually considered as being indigenous to a region beginning about forty miles south of Gray Summit. Recently it has been found southeast of St. Clair in Franklin County. From here it follows the bluffs of the Meramec River for some distance northward, always growing in the cherty soil above the solid limestone. The tree can be seen from a car on the gravel road between Highway 66 at St. Clair and Highway 50 at Union (known locally as the "Union-St. Clair" road), which is a point due west of the Arboretum. The northernmost station, recently discovered,

is on the farm of Gus Patke (figs. 1 and 2), about two miles south of the Missouri River, on the old road between Gildehaus and Labadie. This is about three miles due north of the Arboretum and perhaps twice that far west. Another group, reported west of this point near a place known locally as Pikes Peak, now extends the known range of the tree considerably west of the Arboretum. In both these locations the Short-leaf Pine is demonstrating its aggressiveness by the number of vigorous seedlings found under the older trees and competing with the deciduous trees near by.

On the Patke farm some of the largest trees are over a foot in diameter

Fig. 2. Short-leaf Pine on Gus Patke farm.

and fully fifty feet high. From a small group of these old trees, seedlings radiated in all directions. According to Mr. Patke, pine trees have been growing in this area for as long as any one can remember. Both of these groups are at least six air-line miles from the more extensive groves south of Union. This is all the more interesting since there seems to be no local recollection of pine trees ever growing between these points.

The Short-leaf Pine is symmetrical when young but in old age only the very top remains well formed. However, it is picturesque, and tree planters should find a place for our native pine. It is essentially a timber tree, reaching fifty feet even at its northern limit with a trunk diameter a little over twelve inches. Perhaps it should be used ornamentally only when planted

as a group, as a screen, or shelter belt. It has very few insect enemies, although it may be attacked by a tip moth which tunnels into the leading shoot, causing wilting. If this injury is continued year after year, the tree eventually becomes stunted.

It has been noted in the BULLETIN of May 1940, that one of the reasons for failure with the Short-leaf Pine may be the absence of a mycorrhizal relationship.* The fungus, living on the pine roots, supplements the root hairs as absorbing organs. It has been shown that without the mycorrhiza many plants fail to grow, and that it is especially important to a plant growing beyond its natural range. Actually, the pine may be perfectly comfortable in this locality, but it may be very difficult to develop the mycorrhiza in our soils. Curiously this species has a preference for cherty soils. Although the bluffs along the Meramec River at St. Clair are limestone, the pine grows only on the cherty surface soil which is frequently very thin and infertile. On the Patke farm, there is a layer of sandstone (fig. 2) above the limestone, while the surface layer is a rather thin cherty soil.

The best stand of Short-leaf Pine at the Arboretum is now in its third year. For planting it, a degraded site was selected, and a heavy application of ammonium sulphate was made to the scattered weeds. This resulted in a great improvement in the plant cover. The fertilizer was applied in May and the first lot of 1000 seedlings was planted in the fall. About one half of these died, although they were Missouri-grown plants from the U. S. Forest Service Nursery at Willow Springs, Missouri. In April of 1942 another thousand seedlings from the Soil Conservation Service at Elsberry, Missouri, were planted. The loss in the second planting was considerably less. These seedlings were planted six feet apart in rows six feet apart. During the past spring about 400 more plants were used to fill the vacant spaces. It appears that this planting will be successful although the plants were given much more attention than is usually required for pines. They have been mulched with sawdust and stable manure besides receiving individual applications of commercial fertilizer. Short-Leaf Pine is usually recommended for infertile and seriously eroded sites. Perhaps this is true farther south, although even in Arkansas seedling pines are not found in abandoned fields until the huckleberry (*Vaccinium arboreum* Marsh) has been established. At Gray Summit—near the northern limit of its range—we cannot grow this pine without much care and attention.

* The term *mycorrhizal* refers to a mutually beneficial relationship between a fungus and a host plant. The fungus filaments invade the outer bark tissues of the rootlets and may develop a thick mantel of mycelium (fungus strands) on the outside.

CAN WE GROW THE SNOW TRILLIUM IN MISSOURI?

EDGAR ANDERSON

Of all the sights of early spring none is more breath-taking than a fine stand of the Snow Trillium seen on a bright sunny day. The flower is nearly as large as other trilliums, but the plant is so minute that the little white lilies seem to sprout directly from the soil when they first appear; one author has compared them to a flock of white butterflies settled upon the grass. The flowers are dainty, beautiful, and they appear in the very earliest spring, in March, along with the crocuses and long before the other species of the genus.

It may seem unnecessary to ask if the Snow Trillium *(T. nivale)* can be grown in Missouri since it is actually native here. On the other hand, Missouri is the edge of its range, and it has been found in only a very few localities and by only a few collectors. Some gardeners who have attempted to grow it have kept it alive for only a few seasons. Furthermore, it is one of those plants which are really effective only when they are flowered in masses; a plant or two is interesting to the rock-garden specialist, but for the ordinary person there must be at least ten to twenty Snow Trilliums in flower before he realizes that he is looking at something other than little scraps of white paper down in the grass.

The Snow Trillium is characteristically a plant of the prairies, and to see it in real profusion one needs to go to central Iowa. The indefatigable Father Link has located several stations for it in Illinois, within driving range of St. Louis. In all of these places it is growing on what are technically known as river terraces, and even in Iowa, where it seems to be less finicky about where it grows, it shows a marked preference for such situations.

To get some kind of a definite answer to the question of how growable it it in the St. Louis area, bulbs were secured in 1944 through the interest of Professor J. C. Cunningham of Iowa State College. There was approximately a peck of bulbs, large and small. They were divided into thirds and planted in the Arboretum at Gray Summit at three places along the Circuit Drive: (1) in front of the European beeches, (2) on the south side of the road just to the west of the east bridge over Brush Creek, (3) on the north side of the road in the same vicinity. Last spring there were ten or a dozen flowers in each of the last two localities but none were seen at location No. 1. It is too early to decide whether this initial experiment is a success, but at least it is well started, and in a few years we should get a definite answer to our question "Can we grow the Snow Trillium in Missouri?".

A BRAZILIAN AIR CACTUS

LADISLAUS CUTAK

When winds start to bluster and temperatures begin to descend, plants of these regions prepare themselves for a long winter sleep. Leaves fall from trees and shrubs, flowers wither, fruits ripen and scatter their seeds to await another spring when the warm earth will awaken them. And while this preparation is taking place in the North there is hustle and bustle of another kind in the lands below the equator; for there the earth is making ready for the festive season of flowers. As you doubtless already know, the seasons in the southern hemisphere are opposite to those of the northern, and a winter-blooming plant from Brazil would be a summer-blooming plant here.

In the great American Cactus family there is a group of winter-blooming plants belonging to the genus Rhipsalis. While most of them are epiphytic, growing upon trees in tropical forests, some clamber over rocks or become terrestrial when they fall and root in the humus soil at the base of the trees. At the Garden we have been growing Rhipsalis in soil with great success.

Slightly more than sixty species of Rhipsalis are recognized, and each one of them is a potential house plant. They do well in hanging baskets set in the window or in sunlit porches. About half of them possess slender, terete (cylindrical) stems, while the other half have angled or much-flattened leaf-like joints, somewhat resembling the Zygocactus (Christmas Cactus) or the dwarf Epiphyllum (the Broad-leaf Cactus erroneously called "Night-blooming Cereus"). Although the flowers of Rhipsalis are rather small in comparison with those of other Cactaceae, they are quite numerous and attractive. They are mostly white to cream, but a few have green, yellow, purple, or pink tints. In size they measure from ¼ inch to about an inch across. The largest flowers belong to *Rhipsalis megalantha*, a species hailing from São Sebastião, an island off the coast of Brazil, these measuring fully 1½ inches across. *R. capilliformis*, also from eastern Brazil, has the smallest flowers, being barely ¼ inch across. The commonest species in cultivation is *R. cassutha*.

One of the showiest species of Rhipsalis, in my estimation, is *R. Neves-Armondii*, which deserves to be better known to house-plant lovers. Our plant was received in a shipment of unidentified cacti from the U. S. Department of Agriculture, and was identified after it bloomed last year. This year it again bloomed profusely, starting in early November, and its lemon-like fragrance permeated the air in its immediate vicinity. The blossoms bore a striking resemblance to those of *Pereskia aculeata*, the common "Blade Apple" of the tropical American Atlantic coasts, which is regarded as the most primitive of the Cactus family.

Brazilian Air Cactus *(Rhipsalis Neves-Armondii)*

Rhipsalis Neves-Armondii is composed of many cylindric stems about 5 mm. thick, from the ends of which grow whorls of short terete branches 5–10 cm. long. These again branch and rebranch as the plant becomes older and pendent, the ultimate joints being much shorter. The young growth is Absinthe Green to Biscay Green* (pale green-yellow), darkening in age to Elm Green. The tiny areoles are subtended by a microscopic

* Technical color terms are those of Ridgway's Color Standards and Color Nomenclature.

whitish scale from which, in the young stage, tufts of whitish ascending hairs (2–5 mm. long) often protrude. The areas below the areoles and at the base of the young branches are usually tinted purple. The flowers, which are borne near the tips of the branches, are sessile, seeming to burst out from the epidermis. The epidermal wall splits around the perianth into four very short, membranous appendages which might be mistaken for sepals although the "lobes" have no connection with the flower. Actually there are only four sepals, usually slightly greenish (sometimes with a pink midstripe) in the bud stage, but, because they are hardly distinguishable from the petals, it is prudent to refer to the floral envelope as bearing twelve perianth segments or lobes. The lobes are 7–13 mm. long, the four outer ones being the shortest, white to cream-colored, oblong in shape with obtuse or somewhat acute apices, the apical margins being somewhat dentate. Stamens are 40–60 in number, 5–8 mm. long, the outer ones with white filaments and yellowish bases while the short inner ones are often golden-yellow throughout, imparting a lustrous touch to the center of each flower. Style is white, 8 mm. long, topped by spreading white stigma-lobes, usually four in number (in our plants), each lobe about 3 mm. long. The fruit, not yet seen, is said to be a small crimson berry, about the size of a mistletoe fruit.

ANNUAL COURSE IN HORTICULTURE FOR AMATEURS

A course in horticulture for amateurs, designed to acquaint the participants with principles and practices of gardening, with particular reference to the culture of herbaceous plants, will be given from February 5 to May 7, 1946. The classes will be held in the experimental greenhouse on Tuesdays from 10:00 to 12:00 a. m. The course will be in charge of Dr. Mehlquist.

REGISTRATION: It is desirable that registration be made by letter, with check enclosed payable to the Missouri Botanical Garden, as soon after January 1 as possible. Tickets will be distributed at the experimental greenhouses on day of first lecture.

FEE: The registration fee is $15.00 per student, and tickets are not transferable.

SUBJECT MATTER OF THE COURSE

I. Fundamentals of plant growth.
   - The role played by light, temperature, water and air.
   - The soil and associated materials.
   - Mineral nutrition.

II. Practical points in successful gardening.
   - Choice of location and soil; preparation and improvement of soil.
   - The nature and use of fertilizers.
   - Practical plant propagation: seed sowing, cuttings, and division.
   - Potting and transplanting of seedlings and cuttings.
   - Planting and handling of bulbous plants for forcing during winter.

Selection and general care of house plants.
Identification and control of common garden pests and diseases.
Landscaping the home grounds; design, choice of suitable plants and their care.
Preparation and care of lawns.
Demonstration of various phases of garden work.

(About ¼ of the time will be devoted to theoretical discussions outlined in Section I; the remainder of the time will be devoted to subjects of Section II.)

YOUR QUESTIONS ANSWERED

The editors wish to express their appreciation for the numerous words of approval that have been voiced for the Question-Answer feature that was initiated with the May issue of this year. In order that it may more fully meet the needs of our readers we wish to extend them an invitation to send in questions. While we cannot offer assurance that all will be used, any that are timely and of sufficient general interest will be answered in the BULLETIN.

Do oak leaves make good leaf-mold?

While oak leaves will not decay as rapidly as those of many other trees, there is no reason why they should not be used as a source of excellent leaf-mold. When preparing the leaf pile in the fall add rather liberal applications of lime and a few shovels of soil between the layers of leaves. A few pounds of ammonium phosphate will also speed up the process of decay. The lime will reduce the acidity, the soil will supply the necessary bacteria and fungi, while the ammonium phosphate supplies these organisms with available nitrogen.

It is best to heap the leaves into a pit two or three feet deep as a means of conserving moisture. But if the leaves are simply gathered together on the surface of the ground, the top of the pile should be worked into a broad concavity and watered occasionally. The rate of decay will also be greatly accelerated by turning up the lower layers every month or two.

Is the yellow-wood tree (Cladrastis lutea) hardy in St. Louis?

Yes, it is an excellent wide-spreading ornamental for larger gardens. A heavy mulch of manure will assist in starting a specimen.

Does boxwood brought in from the South do well here?

When properly placed, that is, sheltered from summer and winter winds and planted in good sweet soil, southern boxwood is perfectly at home.

What causes the sap to run out of a cherry tree?

This is called "gummosis," and is an effort of the tree to seal over an injury to the bark (usually from borers). A cherry tree will do this no matter how tiny the bark puncture and no matter what the cause. In itself this exudation is not harmful, but it is an indication that some harm has befallen the tree.

Can lemon verbena be used in cooking?

Because of its rarity little seems to be known of lemon verbena (*Lippia citriodora*). It is said to be used for the preparation of a tea in some European countries, and it affords a very desirable scent for the linen closet. In the 1942 issue of *The Herbarist*, Mary Elizabeth Fitz-Gerald has presented an interesting historical sketch of this plant.

What is the difference between a cold-frame and a hot-bed?

A cold-frame has no source of heat except sunlight. A hot-bed is heated by steam or hot-water pipes, electric cables, or by fermenting farm manure. Otherwise they are identical in construction.

When is the best time to transplant strawberry plants in Missouri?

Transplanting may be done in fall if the young plants are given a protective mulch of

straw to avoid alternate freezing and thawing during the winter. Transplanting in spring, however, is standard procedure in Missouri.

When planting seeds in flats, can they be left in a basement until sprouted?

Yes, provided the temperature and moisture factors are favorable to normal growth of the seeds planted.

How do you improve heavy clay garden soil?

Apply about a 3-inch top-mulch of compost soil, leaf-mold, or farm manure, add a generous amount of coarse sand and mix it thoroughly with the clay soil by spading, plowing, or discing. Repeat this treatment every year until soil of the desired texture is obtained.

NOTES

Dr. C. W. Dodge, Mycologist to the Garden, has been appointed Director of Botany in the Merit Badge Program, St. Louis Council, Boy Scouts of America.

A group of about thirty Juniors from the Barat Catholic Action Center, accompanied by one of the teachers, visited the library and the chrysanthemum show at the Garden on November 19.

Dr. Edgar Anderson, Geneticist to the Garden, attended a conference on hybrid corn in relation to the wet milling industry, which was held in Chicago, November 28-30, under the auspices of the Corn Industry Research Foundation.

Dr. Hugh C. Cutler spent several days at the Garden during December in a study of the plants he collected in Brazil. Dr. Cutler is one of the nine former graduate students of the Garden who was engaged in rubber or quinine investigation in South America during the War.

The following orchid growers have visited the orchid greenhouses at the Arboretum recently: Mr. Maxen Cohen, of Orchidville, Mass.; Mr. L. Ariza and Pierre Villera, of the Dominican Republic, W. I.; Mr. Walton M. R. Riffe, of Dayton, Ohio; Mr. Robert Yohler and Mr. Robert Mitchell, of the Stephen Foster Co., Carmel, Ind.

Recent visitors to the Garden include: Prof. Jacques Rousseau, Director of the Montreal Botanic Gardens, Montreal, Canada; Dr. Julian A. Steyermark, Assistant Curator of the Herbarium, Chicago (Field) Museum of Natural History; Mrs. J. A. Steyermark (Cora Shoop); Mrs. Hazel B. De Lange, of the De Lange Floral Co., Littleton, Colorado; Maj. Ray Gordon, formerly a graduate student at the Garden, recently with the U. S. Air Forces in India; Mr. T. MacDougall and Mr. Clifford Poulsen; Dr. Harry J. Fuller, Associate Professor of Botany, University of Illinois, Urbana; Maj. Richard B. Walker, graduate student, University of California; Mrs. Richard B. Walker (Helen Bramsch); Dr. W. L. Tolstead, Biologist, Conservation and Survey Division, University of Nebraska, Lincoln.

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